EXHIBIT J

Exhibit A-28
Invalidity Claim Chart for U.S. Patent No. 7,924,802 vs. U.S. Patent No. 6,952,454

U.S. Patent No. 6,952,454 ("Jalali") was filed on July 12, 2020 and issued on October 4, 2005. Jalali anticipates asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of U.S. Patent No. 7,924,802 ("the '802 Patent") under 35 U.S.C. § 102. Jalali also renders obvious asserted claims 1–4, 6–10, 13, 14, 17, and 21–24 of the '802 Patent under 35 U.S.C. § 103, alone based on the state of the art and/or in combination with one or more other references identified in Exs. A-1–A-31, Cover Pleading, and First Supplemental Ex. A-Obviousness Chart.[1]

To the extent Plaintiff alleges that Jalali does not disclose any particular limitation of the asserted claims in the '802 Patent, either expressly or inherently, it would have been obvious to a person of ordinary skill in the art as of the priority date of the '802 Patent to modify Jalali and/or to combine the teachings of Jalali with other prior art references, including but not limited to the present prior art references found in Exs. A-1–A-31, Cover Pleading, First Supplemental Ex. A-Obviousness Chart, and the relevant section of charts for other prior art for the '802 Patent in a manner that would render the asserted claims of these patents invalid as obvious.

With respect to the obviousness of the asserted claims of the '802 Patent under 35 U.S.C. § 103, one or more of the principles enumerated by the United States Supreme Court in *KSR v. Teleflex*, 550 U.S. 398 (2007) apply, including: (a) combining various claimed elements known in the prior art according to known methods to yield a predictable result; and/or (b) making a simple substitution of one or more known elements for another to obtain a predictable result; and/or (c) using a known technique to improve a similar device or method in the same way; and/or (d) applying a known technique to a known device or method ready for improvement to yield a predictable result; and/or (e) choosing from a finite number of identified, predictable solutions with a reasonable expectation of success or, in other words, the solution was one which was "obvious to try"; and/or (f) a known work in one field of endeavor prompting variations of it for use either in the same field or a different field based on given design incentives or other market forces in which the variations were predictable to one of ordinary skill in the art; and/or (g) a teaching, suggestion, or motivation in the prior art that would have led one of ordinary skill in the art to modify the prior art reference or to combine the teachings of various prior art references to arrive at the claimed invention. It therefore would have been obvious to one of ordinary skill in the art to combine the disclosures of these references in accordance with the principles and rationales set forth above.

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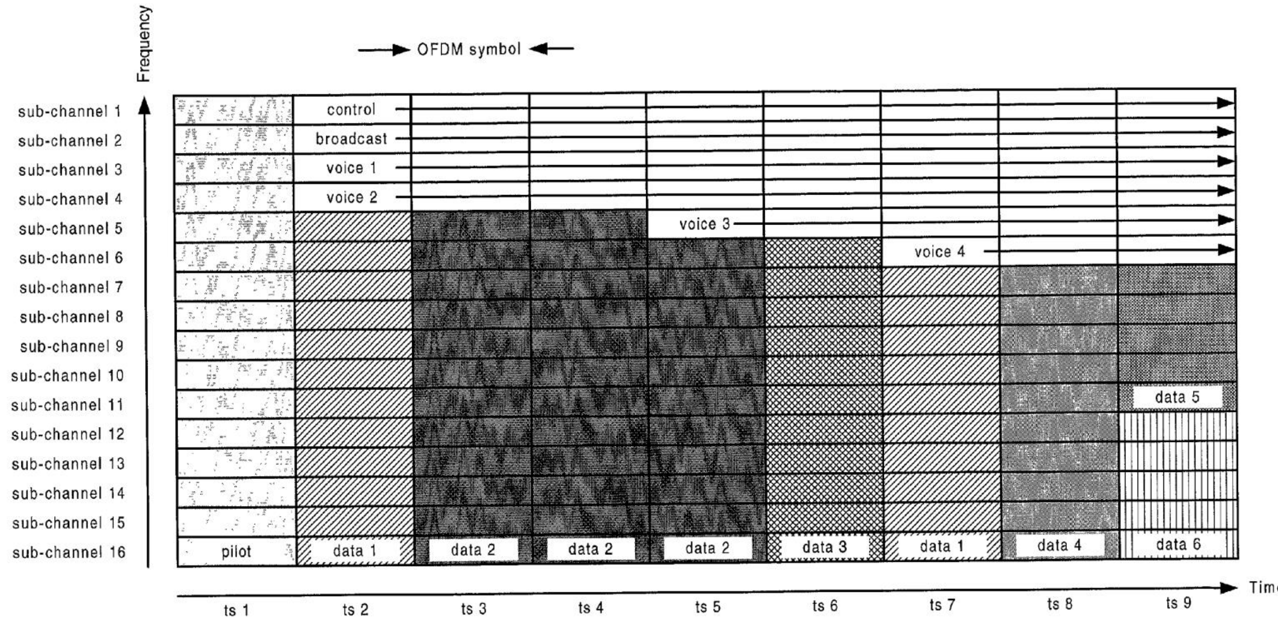
[1] Samsung is investigating this prior art and has not yet completed discovery from third parties, who may have relevant information concerning the prior art, and therefore, Samsung reserves the right to supplement this chart after additional discovery is received. To the extent that any of the prior art discloses the same or similar functionality or feature(s) of any of the accused products, Samsung reserves the right to argue that said feature or functionality does not practice any limitation of any of the asserted claims, and to argue, in the alternative, that if said feature or functionality is found to practice any limitation of any of the asserted claims in the '802 Patent, then the prior art reference teaches the limitation and that the claim is not patentable.

The citations to portions of any reference in this chart are exemplary only. For example, a citation that refers to or discusses a figure or figure item should be understood to also incorporate by reference that figure and any additional descriptions of that figure as if set forth fully therein. Samsung reserves the right to rely on the entirety of the references cited in this chart to show that the asserted claims of the ’802 Patent are invalid. Citations presented for one claim limitation are expressly incorporated by reference into all other limitations for that claim as well as all limitations of all claims on which that claim depends. Samsung also reserves the right to rely on additional citations or sources of evidence that also may be applicable, or that may become applicable in light of claim construction, changes in Plaintiff’s infringement contentions, and/or information obtained during discovery as the case progresses.

Claim 1 of the ’802 Patent	**Prior Art Reference – Jalali**
[1.1] A method of transmitting information in a wireless communication channel comprising:	To the extent the preamble is limiting, Jalali discloses “A method of transmitting information in a wireless communication channel comprising.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.2] transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first highest frequency, and a first lowest frequency; and	Jalali discloses "transmitting first information across a first frequency range using a wireless transmitter, the first frequency range having a first center frequency, a first highest frequency, and a first lowest frequency." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 2 *See*, *e.g.*, Jalali at Figure 2.

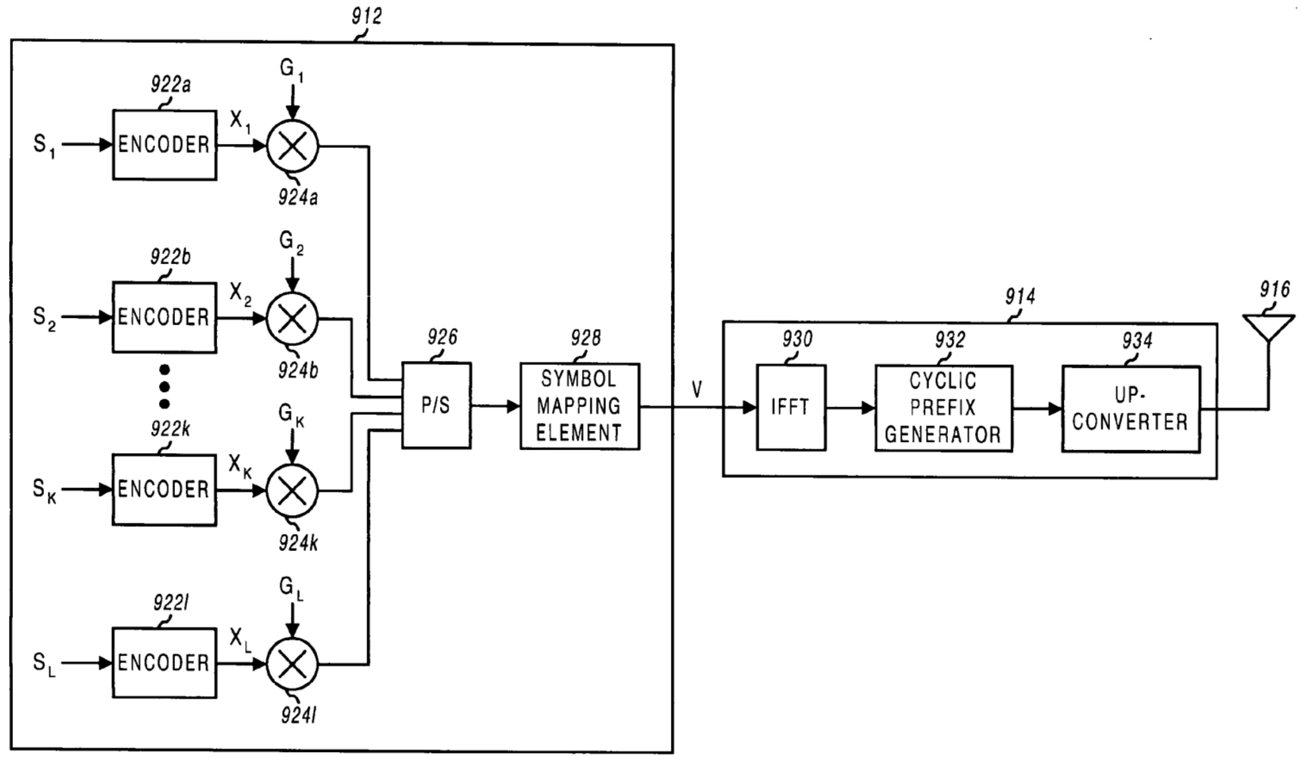
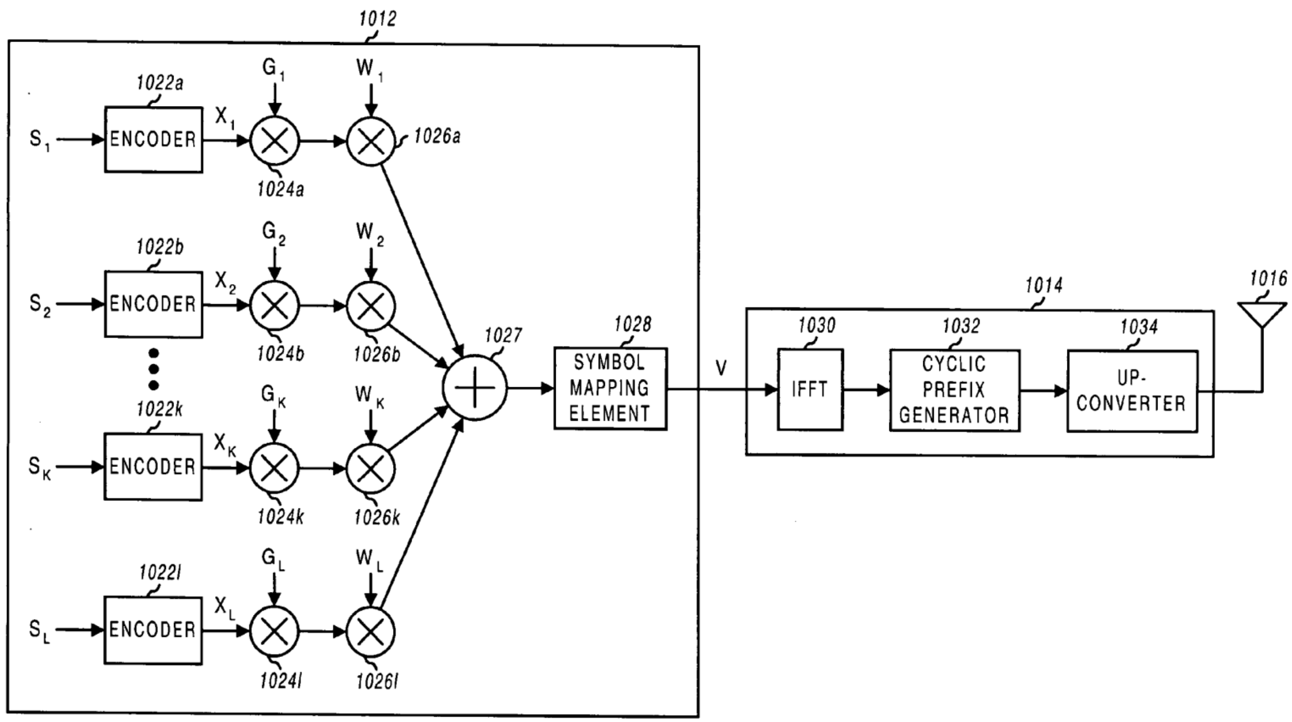
<table>
<tr><th>Claim 1 of the ’802 Patent</th><th>Prior Art Reference – Jalali</th></tr>
<tr><td></td><td>

FIG. 9

See, e.g., Jalali at Figure 9.</td></tr>
</table>

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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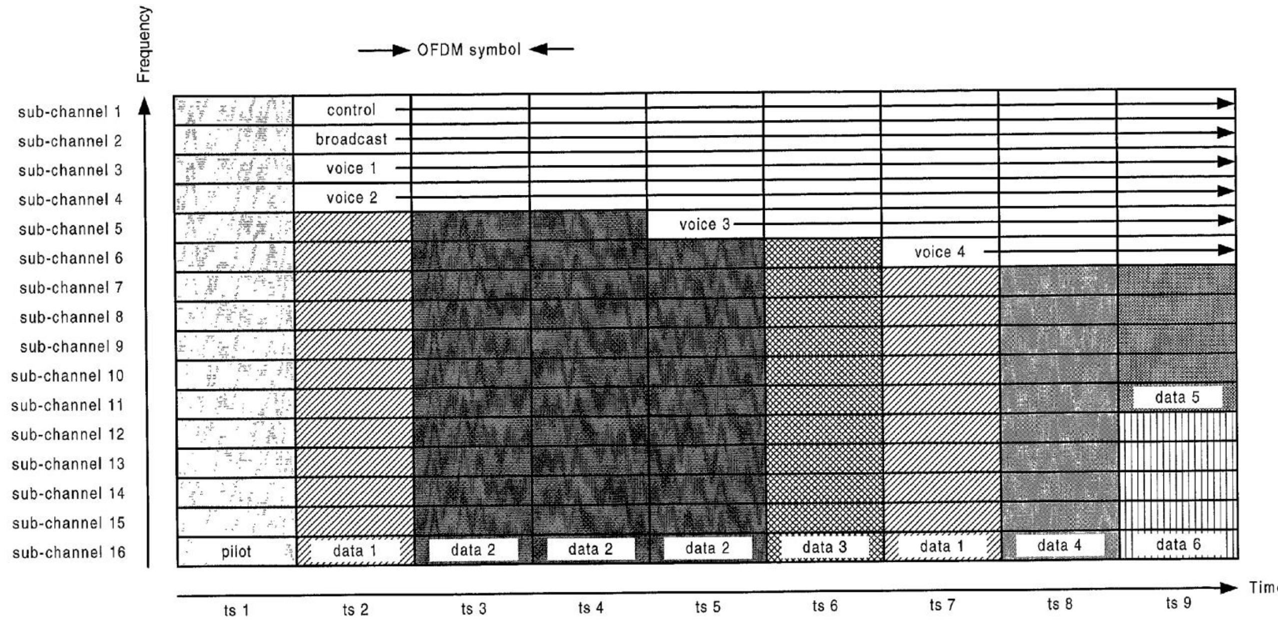
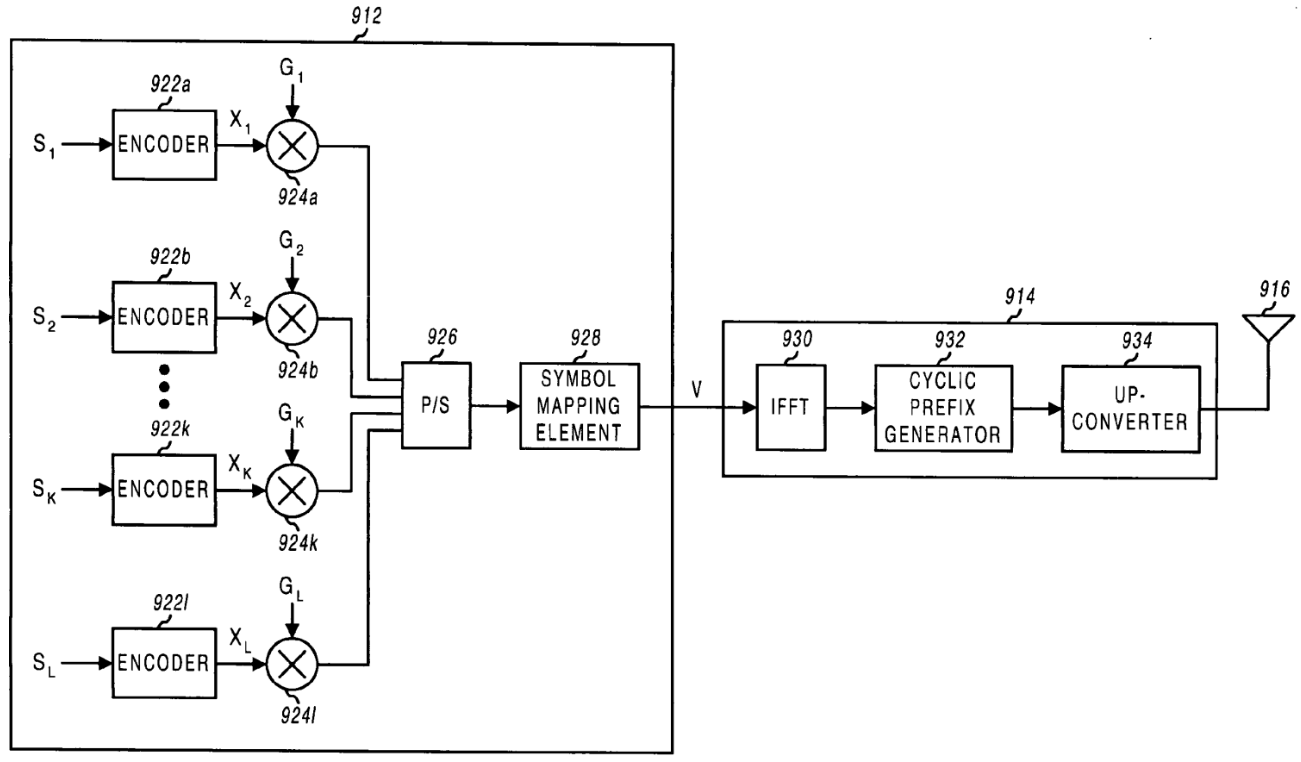
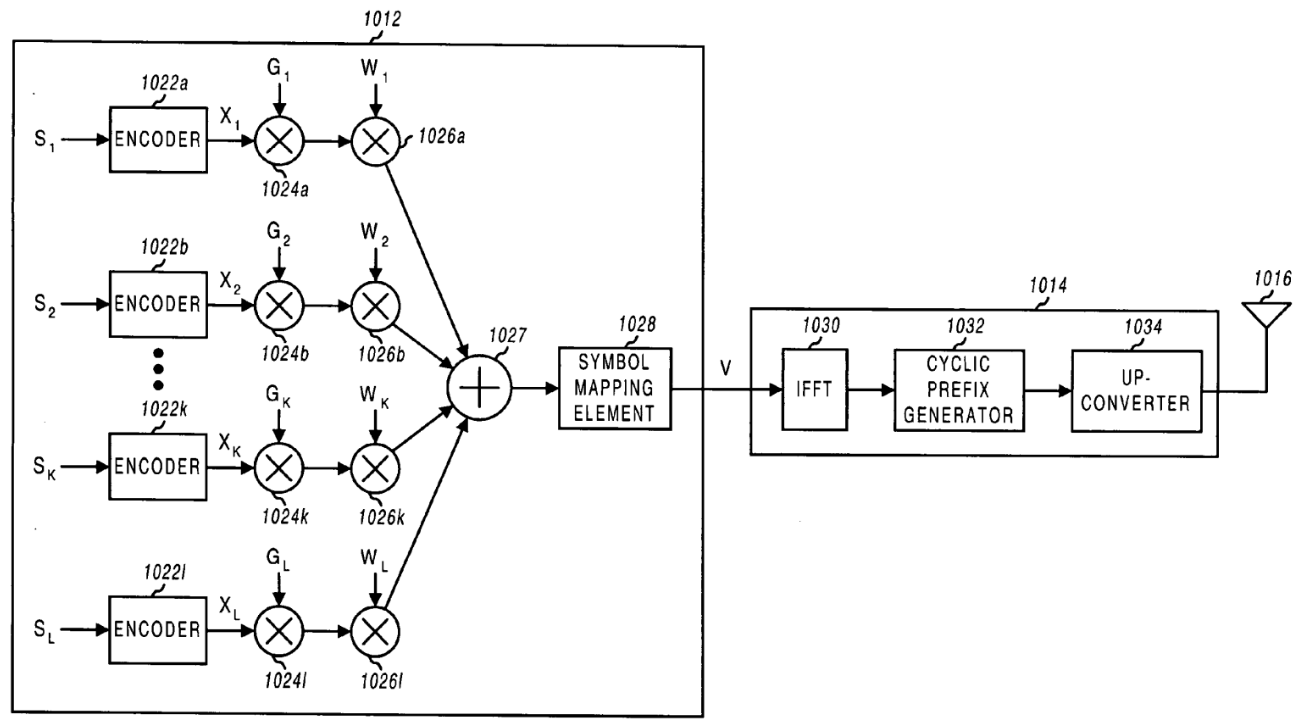
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[1.3] simultaneously transmitting second information across a second frequency range using the same wireless transmitter, the second frequency range having a second center frequency greater than the first center frequency, a second highest frequency, and a second lowest frequency.	Jalali discloses “simultaneously transmitting second information across a second frequency range using the same wireless transmitter, the second frequency range having a second center frequency greater than the first center frequency, a second highest frequency, and a second lowest frequency.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  **FIG. 2** *See*, *e.g.*, Jalali at Figure 2.

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 1 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

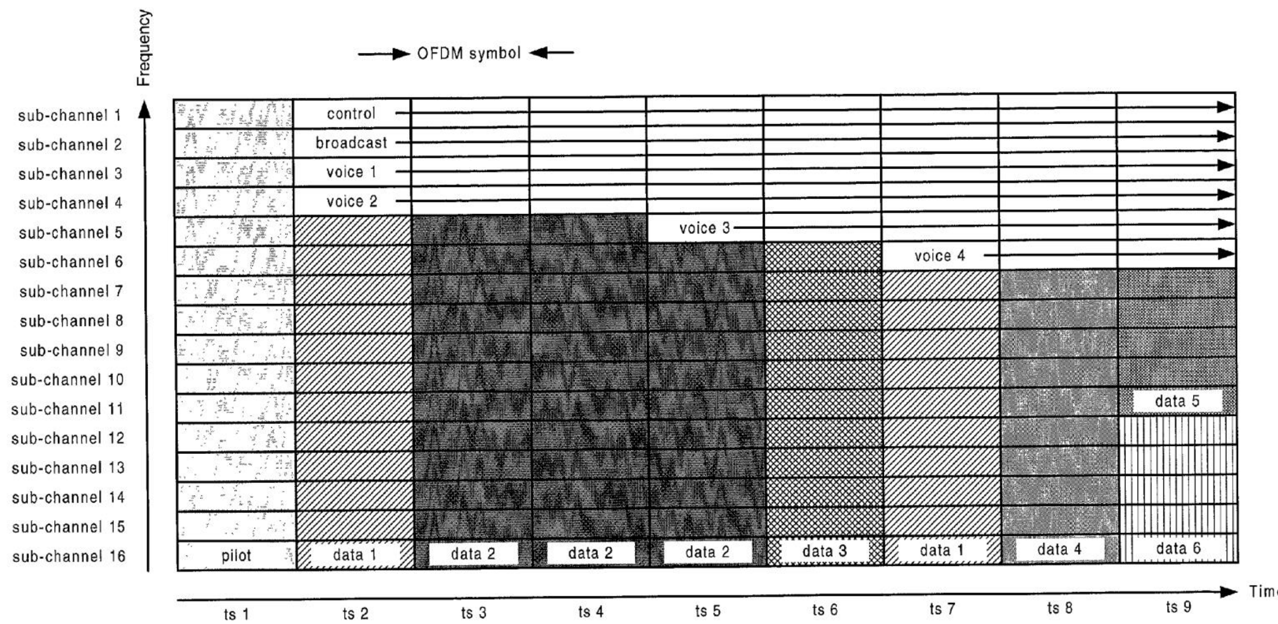
Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

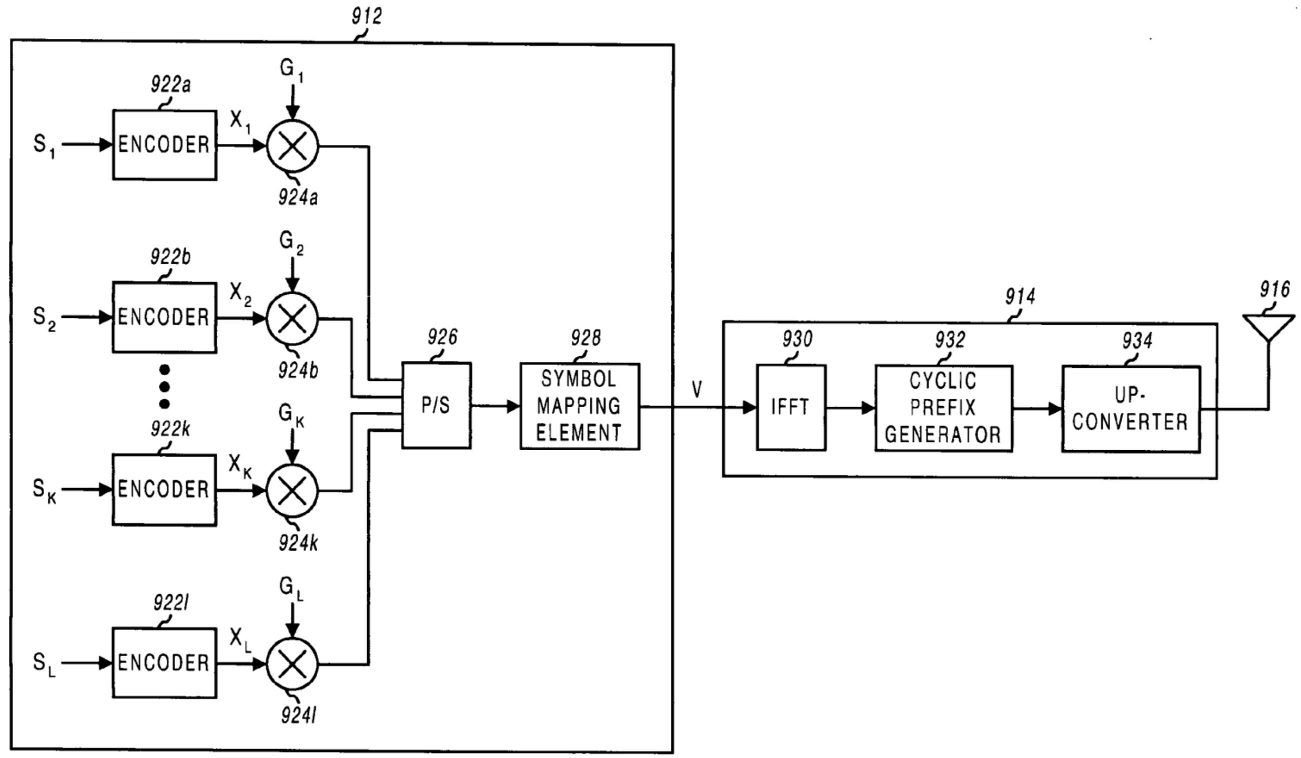
Claim 1 of the '802 Patent	**Prior Art Reference – Jalali**
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

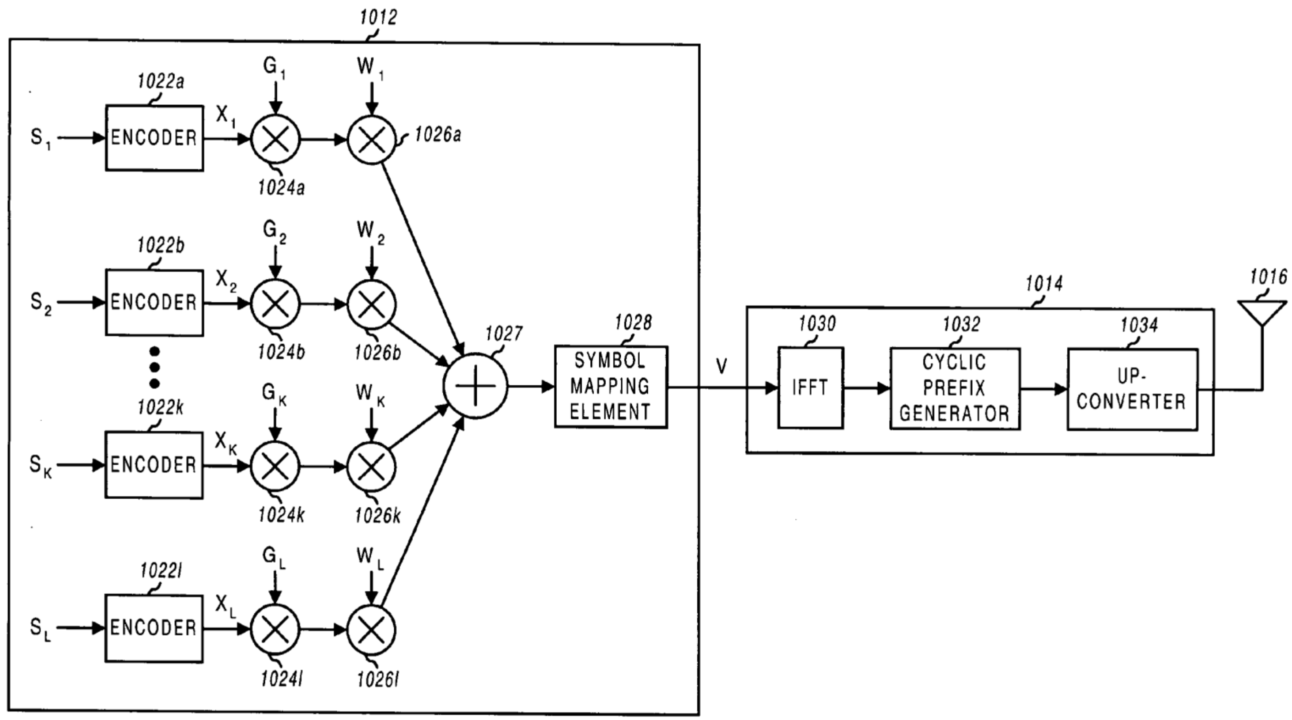
Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 1 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 2 of the ’802 Patent	Prior Art Reference – Jalali
[2.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[2.2] wherein frequency difference between the first center frequency and the second center frequency is greater than the sum of one-half the first frequency range	Jalali discloses “wherein frequency difference between the first center frequency and the second center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
and one-half the second frequency range.	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  *FIG. 2*

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 2 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

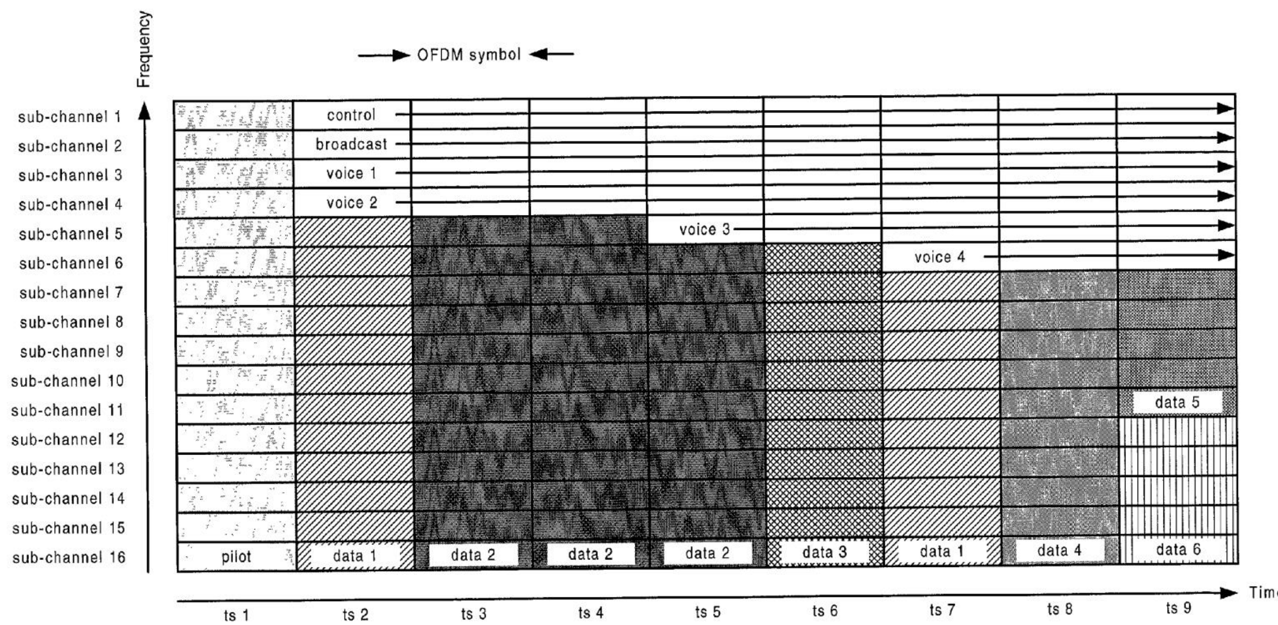
Claim 2 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

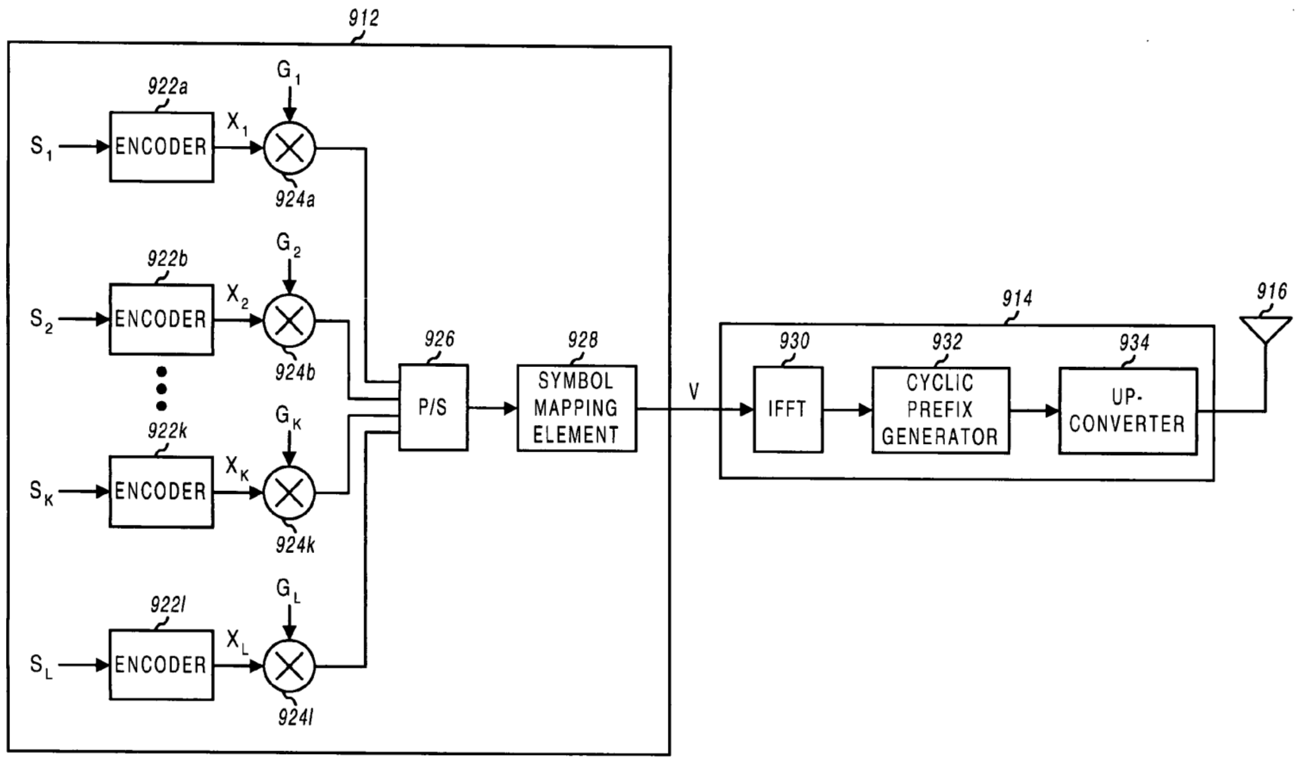
Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

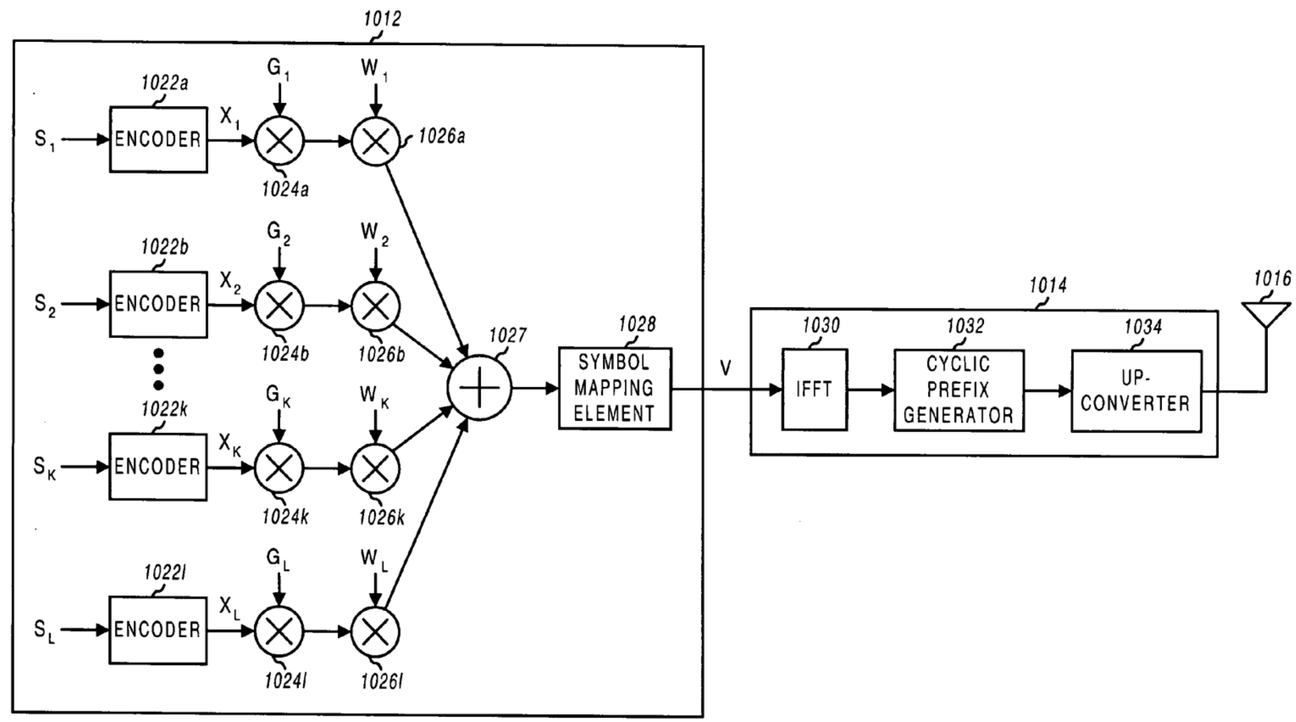
Claim 2 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 2 of the ’802 Patent	**Prior Art Reference – Jalali**
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 3 of the ’802 Patent	**Prior Art Reference – Jalali**
[3.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[3.2] wherein the first and second information are transmitted using the same power amplifier in said wireless transmitter.	Jalali discloses “wherein the first and second information are transmitted using the same power amplifier in said wireless transmitter.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  **FIG. 2**

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 3 of the ’802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See*, *e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See*, *e.g.*, Jalali at 1:24-28.

Claim 3 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 3 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 3 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

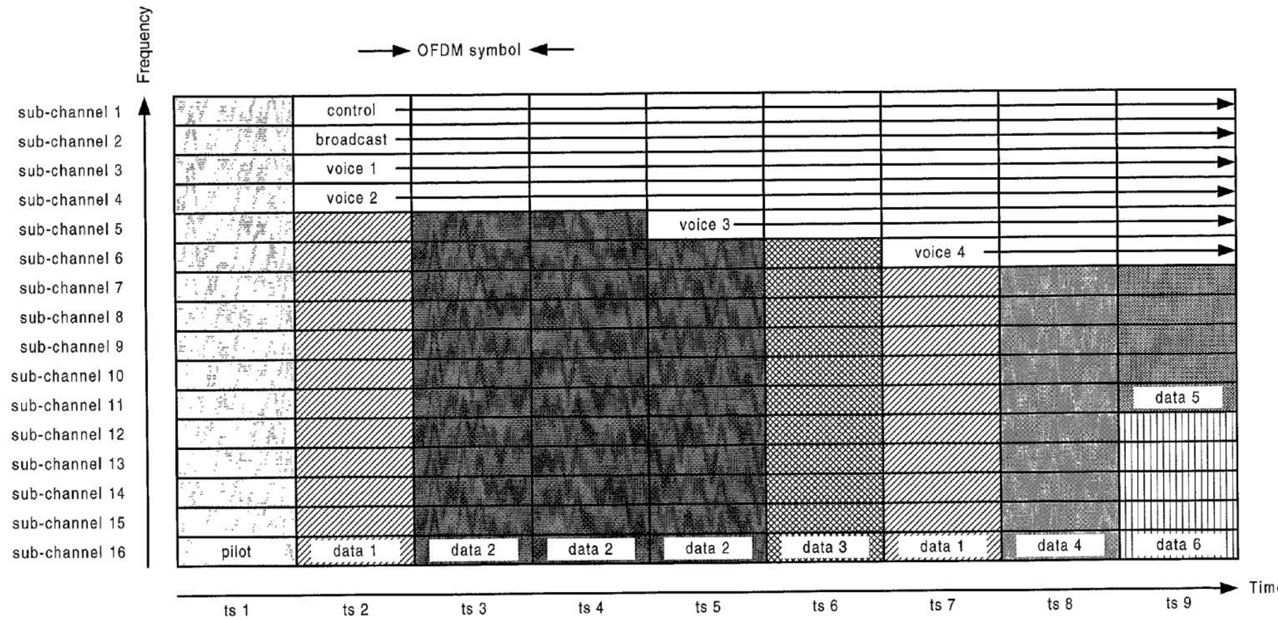
Claim 3 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

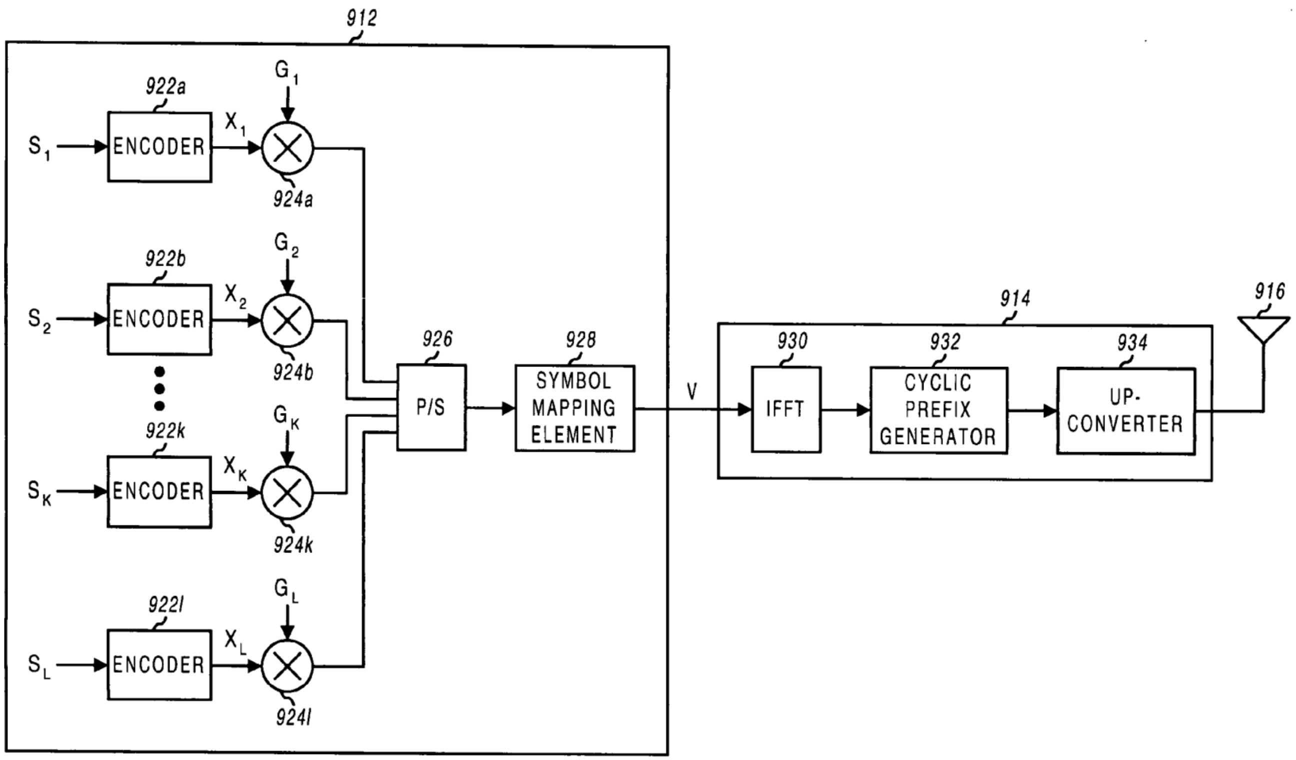
Claim 3 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

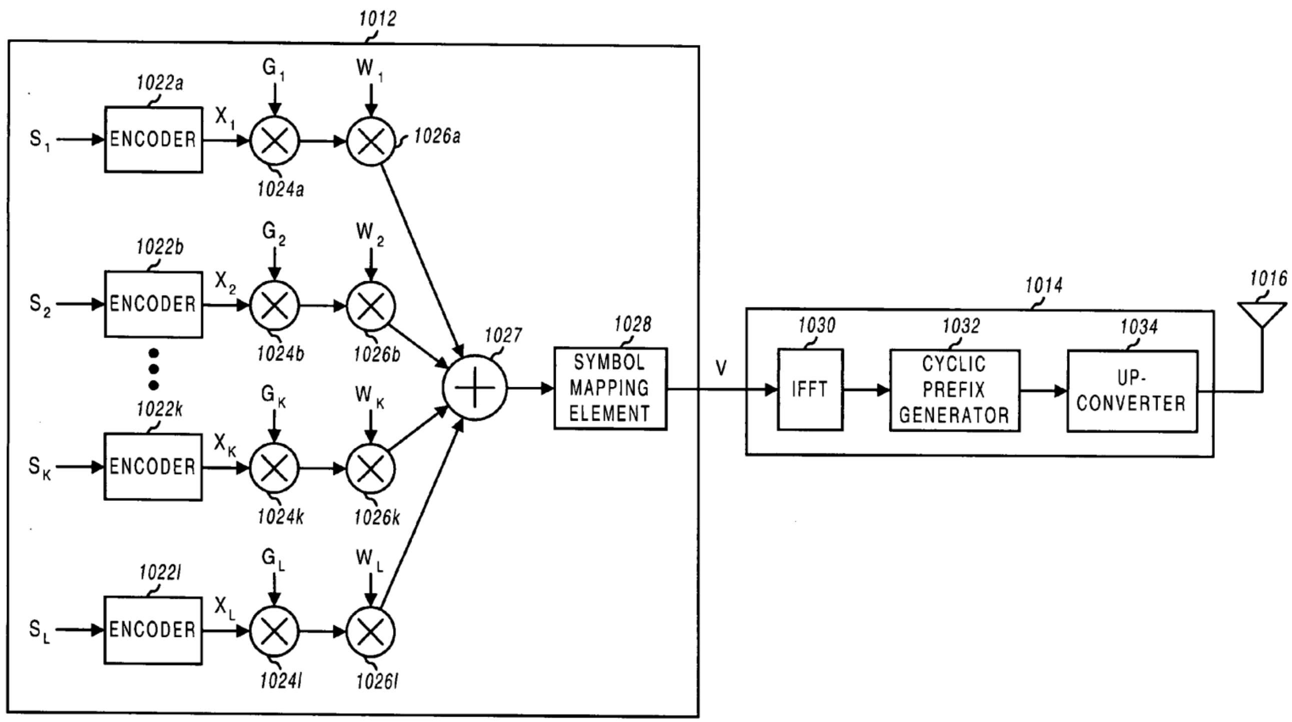
Claim 3 of the '802 Patent	**Prior Art Reference – Jalali**
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 3 of the ’802 Patent	**Prior Art Reference – Jalali**
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 4 of the ’802 Patent	**Prior Art Reference – Jalali**
[4.1] The method of claim 3	Jalali discloses all the elements of claim 3 for all the reasons provided above.
[4.2] wherein the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency.	Jalali discloses "wherein the bandwidth of said power amplifier is greater than the difference between the first lowest frequency and the second highest frequency." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 4 of the '802 Patent	**Prior Art Reference – Jalali**
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 4 of the '802 Patent	**Prior Art Reference – Jalali**
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 4 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See*, *e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

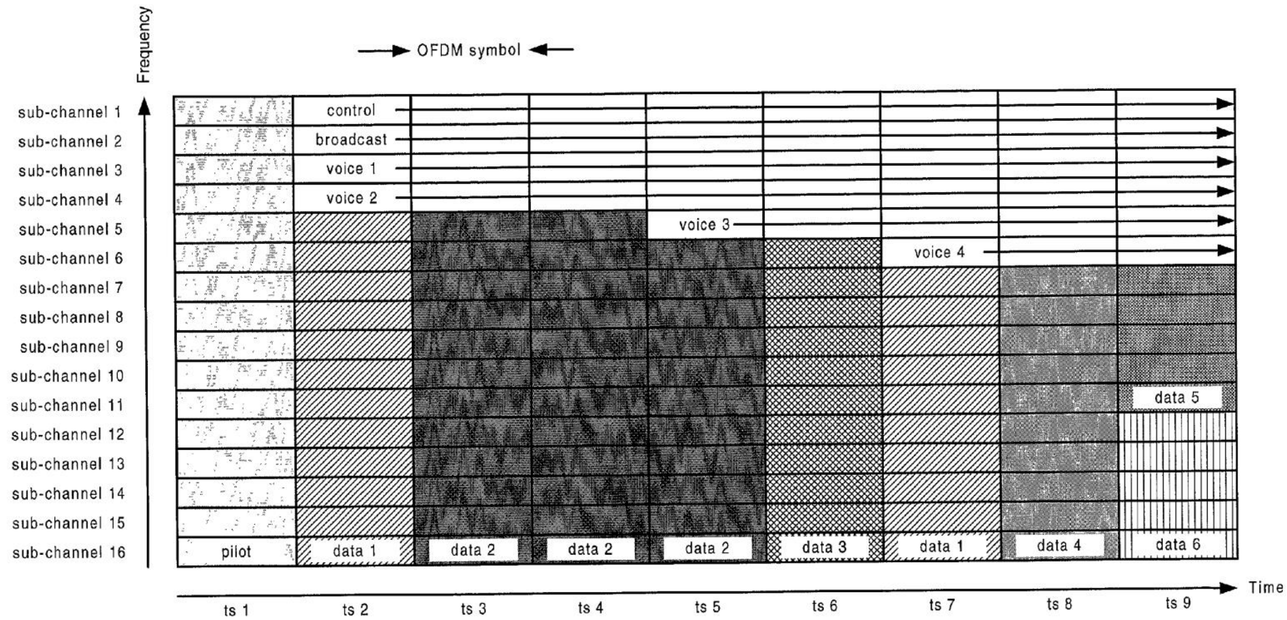
Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

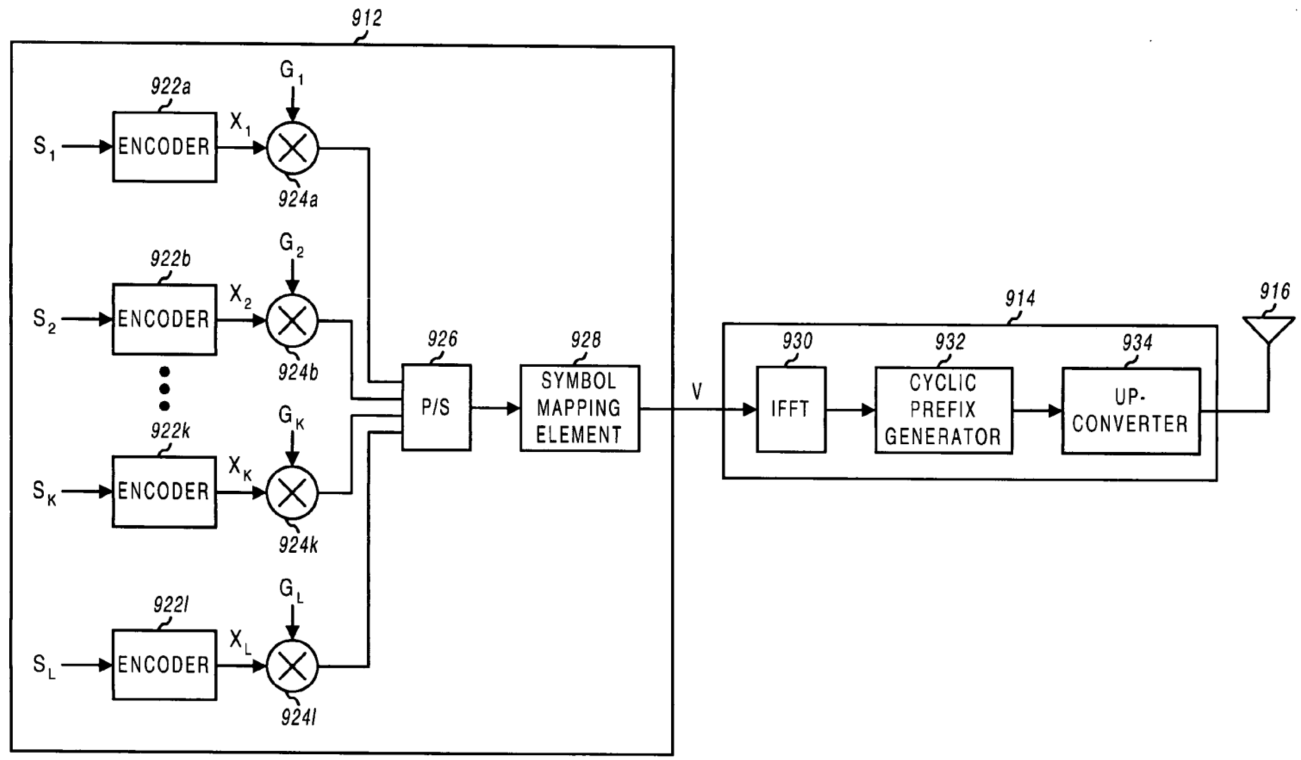
Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

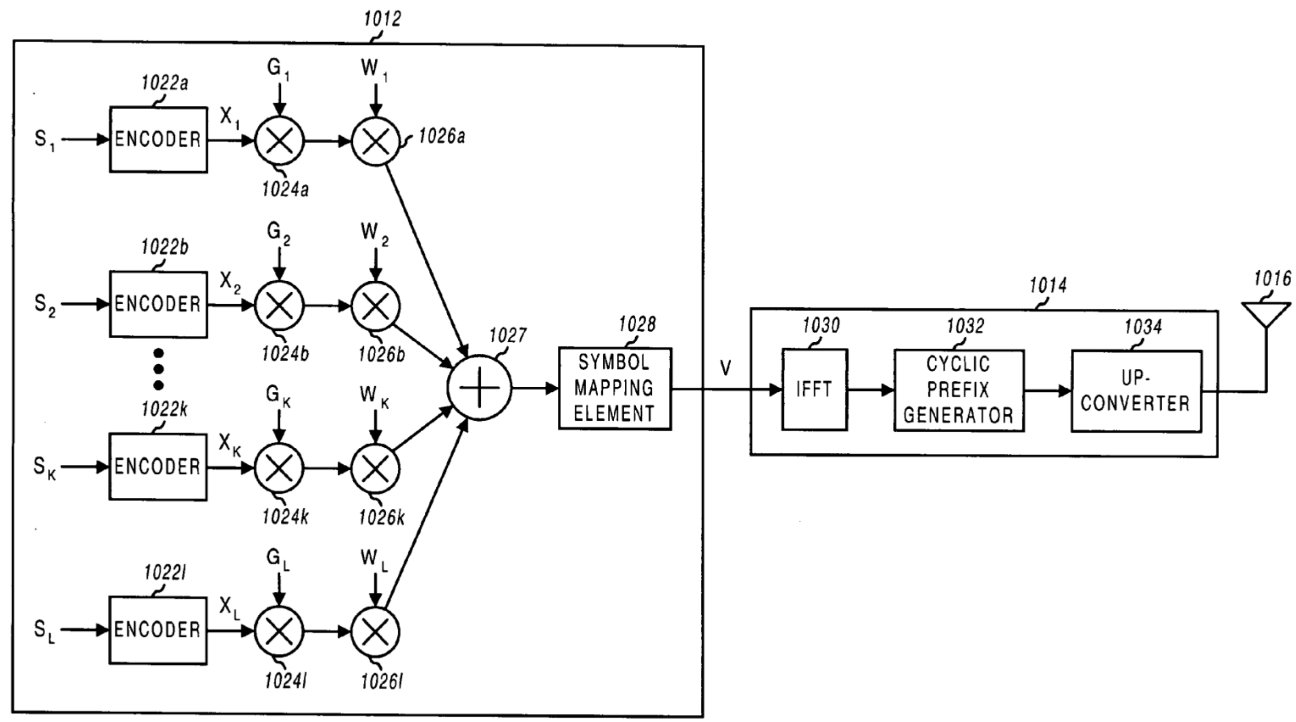
Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 4 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
[6.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[6.2] wherein the first information corresponds to a first wireless protocol and the second information corresponds to a second wireless protocol.	Jalali discloses "wherein the first information corresponds to a first wireless protocol and the second information corresponds to a second wireless protocol." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 6 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 6 of the '802 Patent	**Prior Art Reference – Jalali**
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

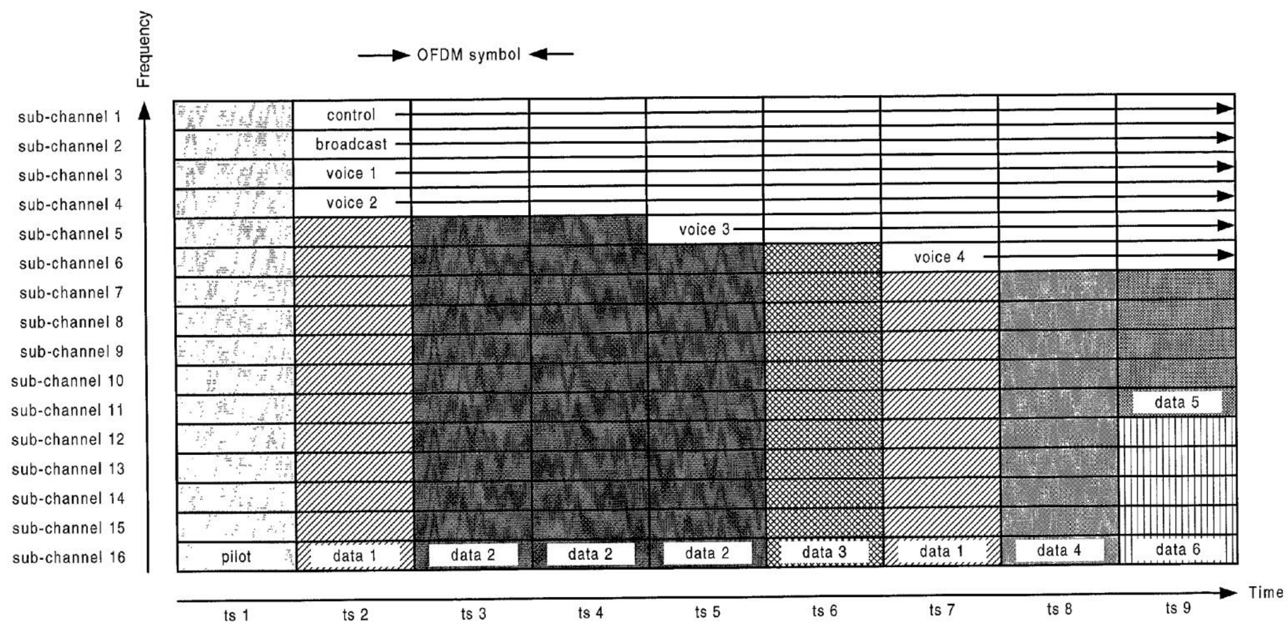
Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

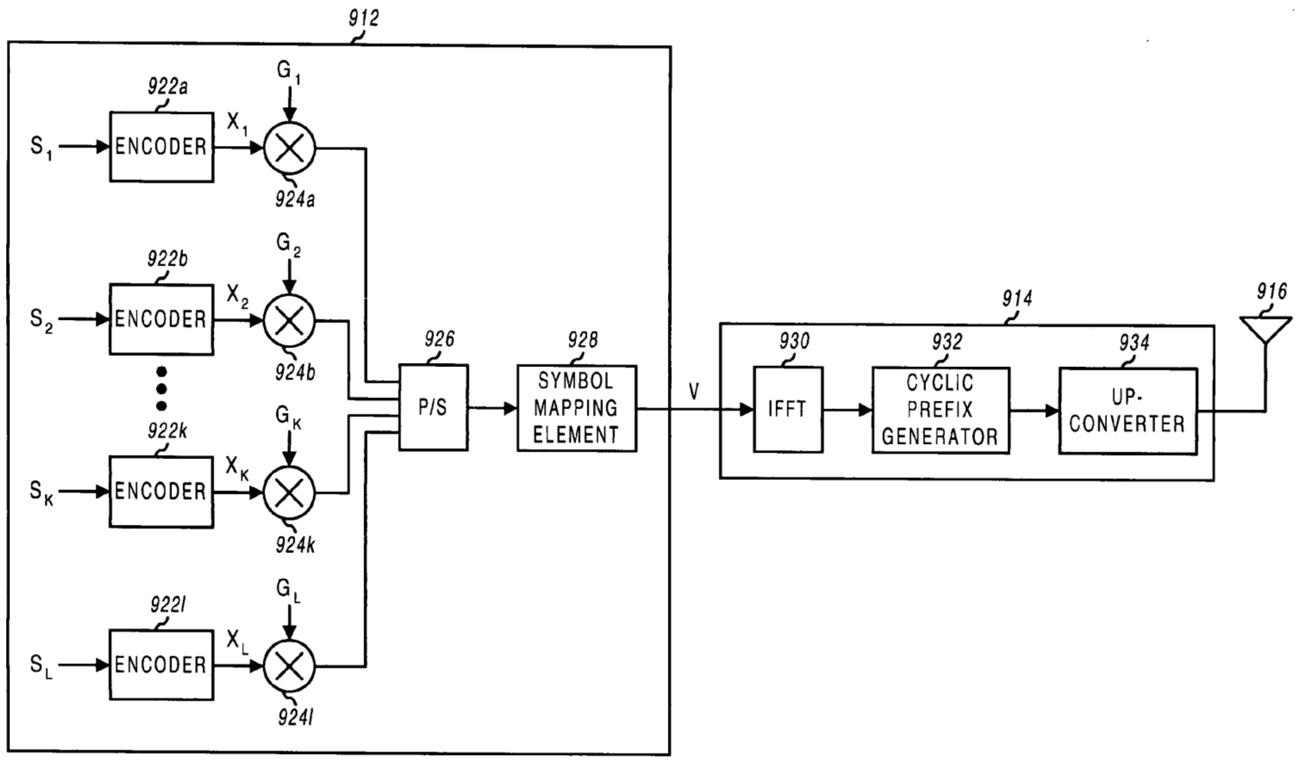
Claim 6 of the '802 Patent	**Prior Art Reference – Jalali**
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

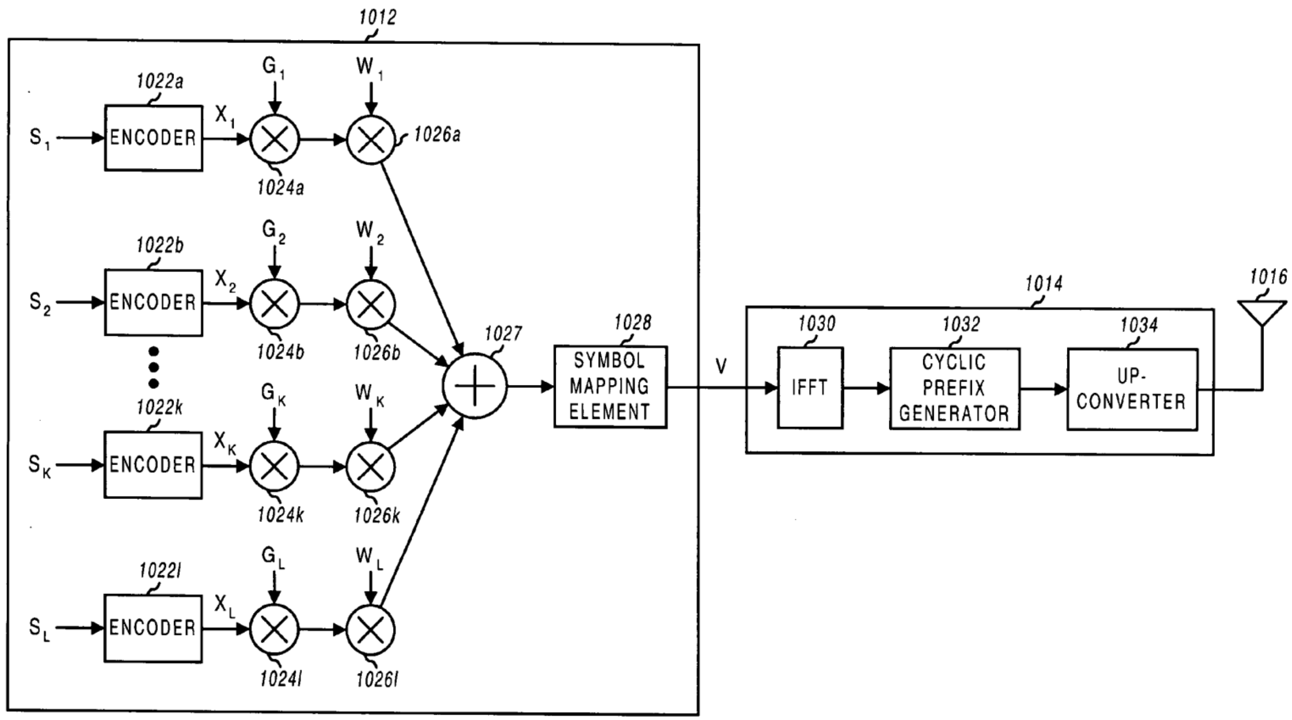
Claim 6 of the ’802 Patent	**Prior Art Reference – Jalali**
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 6 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
[7.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[7.2] wherein the first information and the second information are the same data transmitted across two different frequencies.	Jalali discloses "wherein the first information and the second information are the same data transmitted across two different frequencies." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2*

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 7 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 7 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 7 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

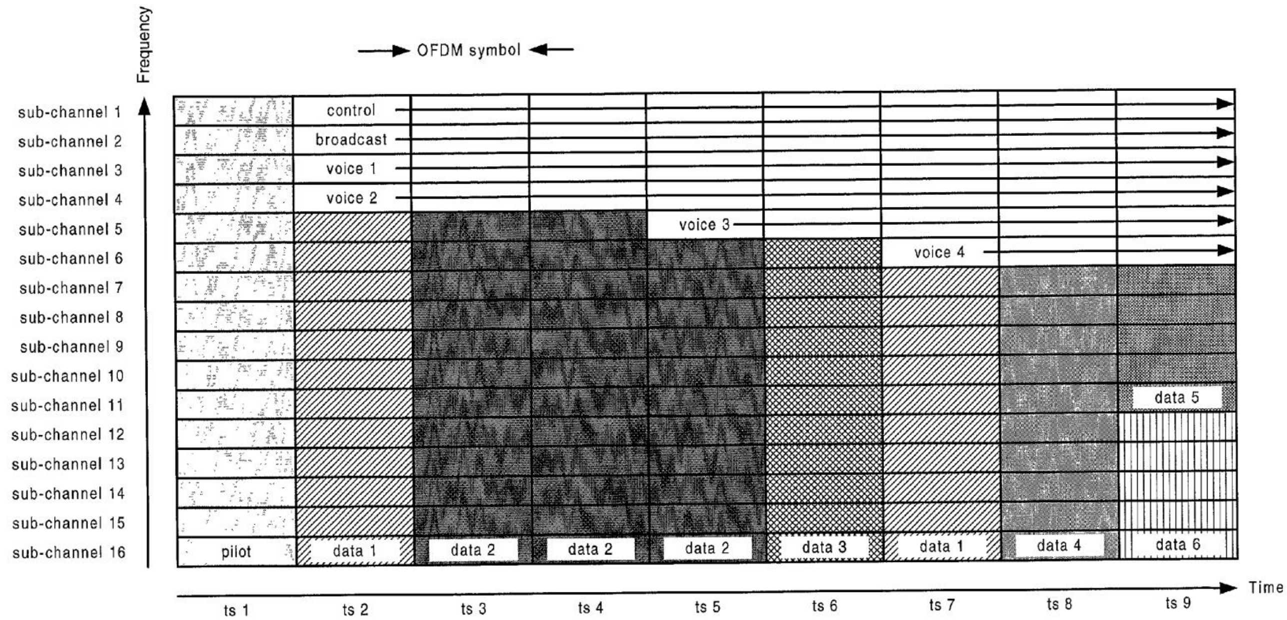
Claim 7 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

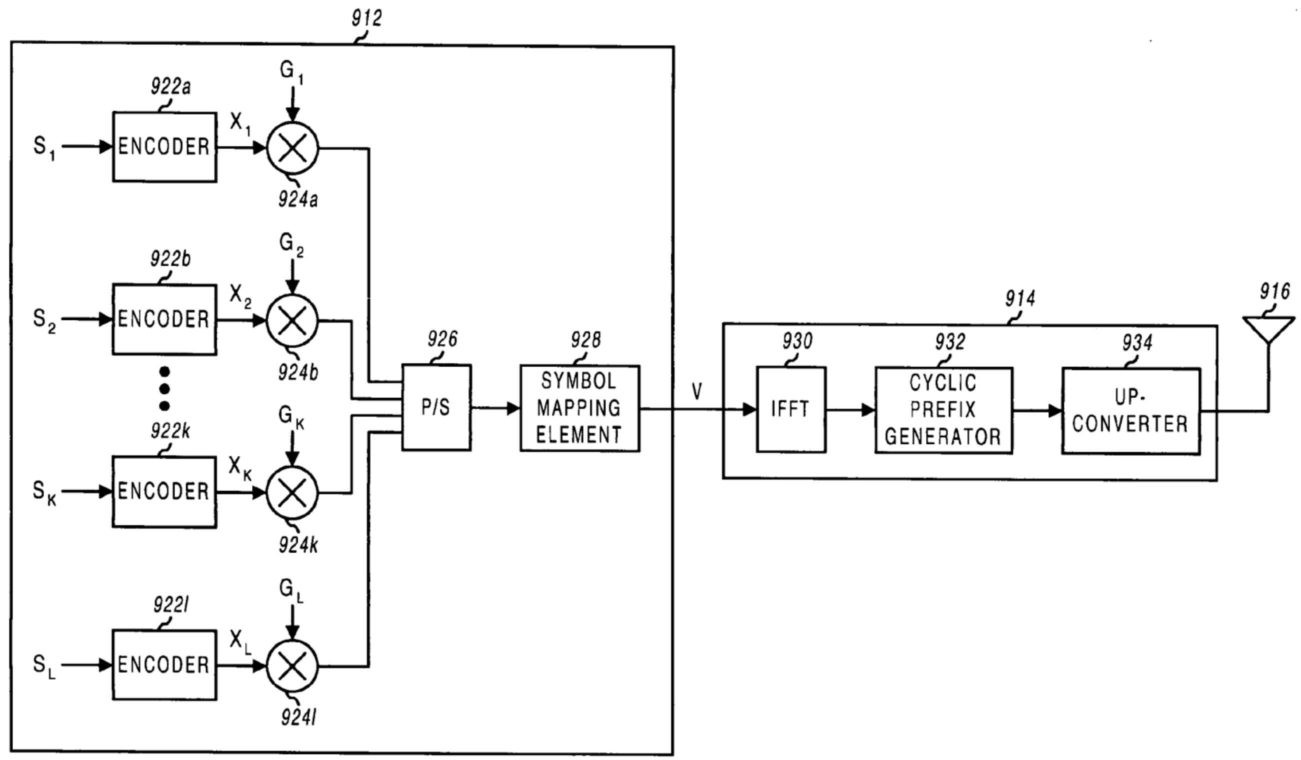
Claim 7 of the ’802 Patent	**Prior Art Reference – Jalali**
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

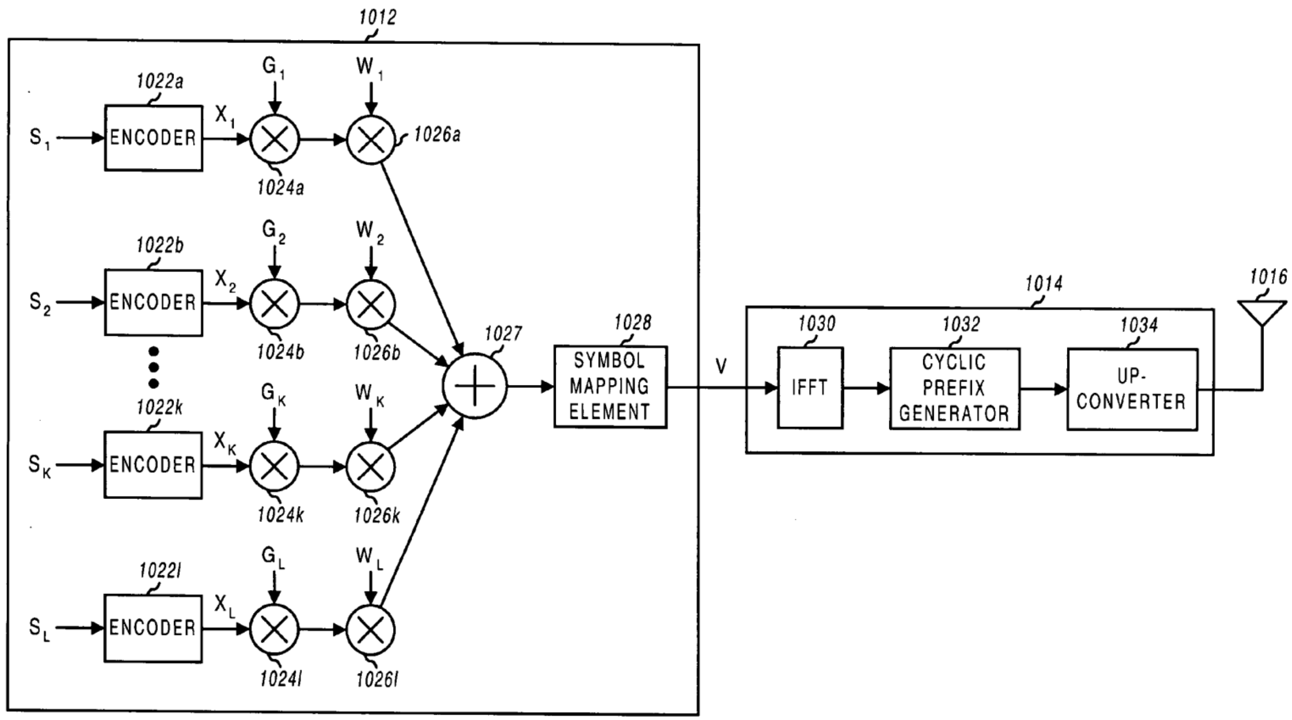
Claim 7 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 7 of the ’802 Patent	**Prior Art Reference – Jalali**
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 8 of the ’802 Patent	**Prior Art Reference – Jalali**
[8.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[8.2] wherein the first information and the second information are from the same data stream.	Jalali discloses “wherein the first information and the second information are from the same data stream.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 8 of the ’802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See*, *e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See*, *e.g.*, Jalali at 1:24-28.

Claim 8 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 8 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 8 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 8 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 9 of the ’802 Patent	Prior Art Reference – Jalali
[9.1] The method of claim 1	Jalali discloses all the elements of claim 1 for all the reasons provided above.
[9.2] wherein first information and second information comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first frequency range and a second	Jalali discloses “wherein first information and second information comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first frequency range and a second symbol is transmitted during the first time slot across the second frequency range, and wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range.” See, e.g.:

Claim 9 of the ’802 Patent	**Prior Art Reference – Jalali**
symbol is transmitted during the first time slot across the second frequency range, and wherein a third symbol is transmitted during a second time slot across the first frequency range and a fourth symbol is transmitted during the second time slot across a second frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.

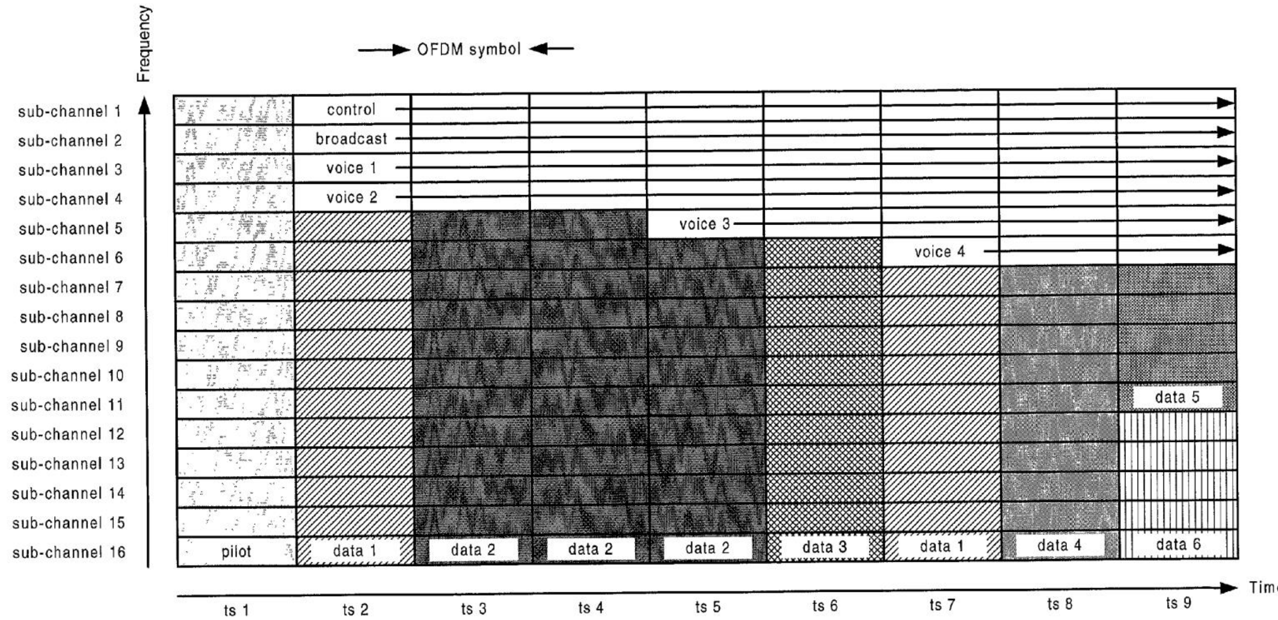
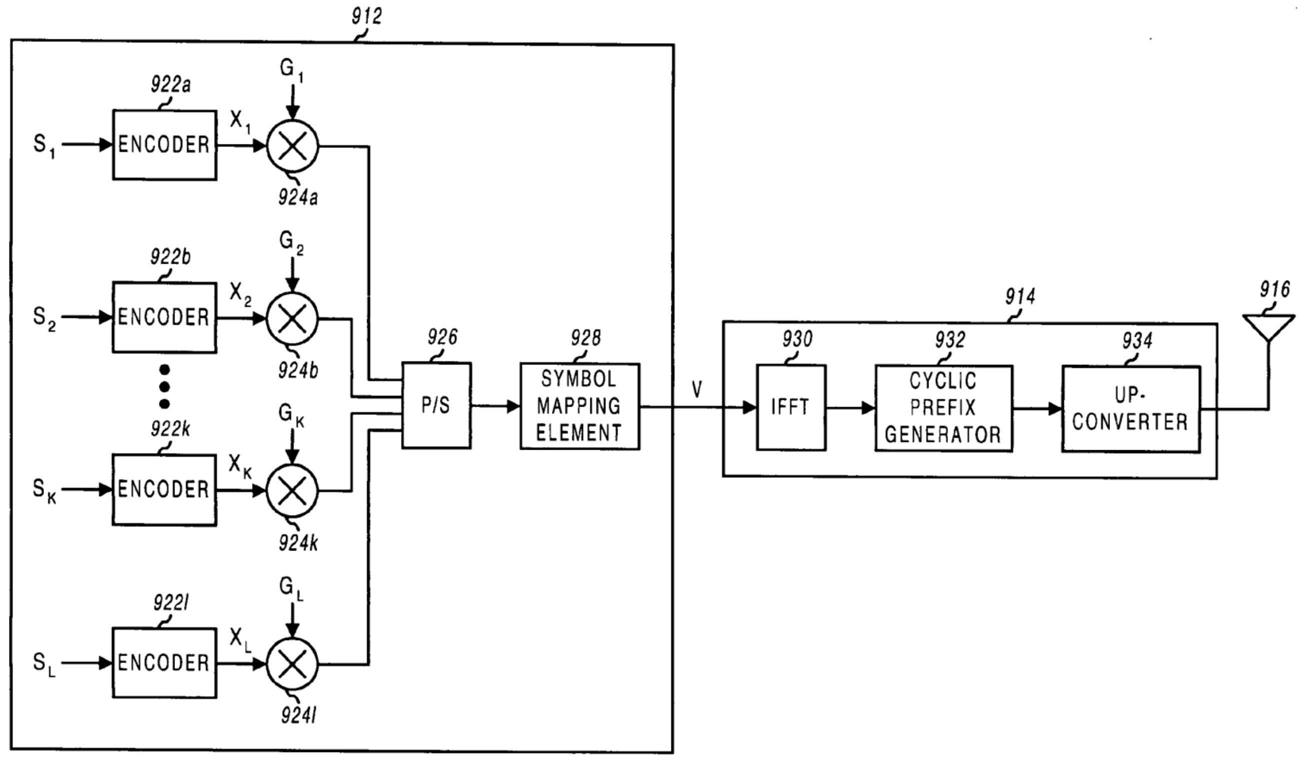
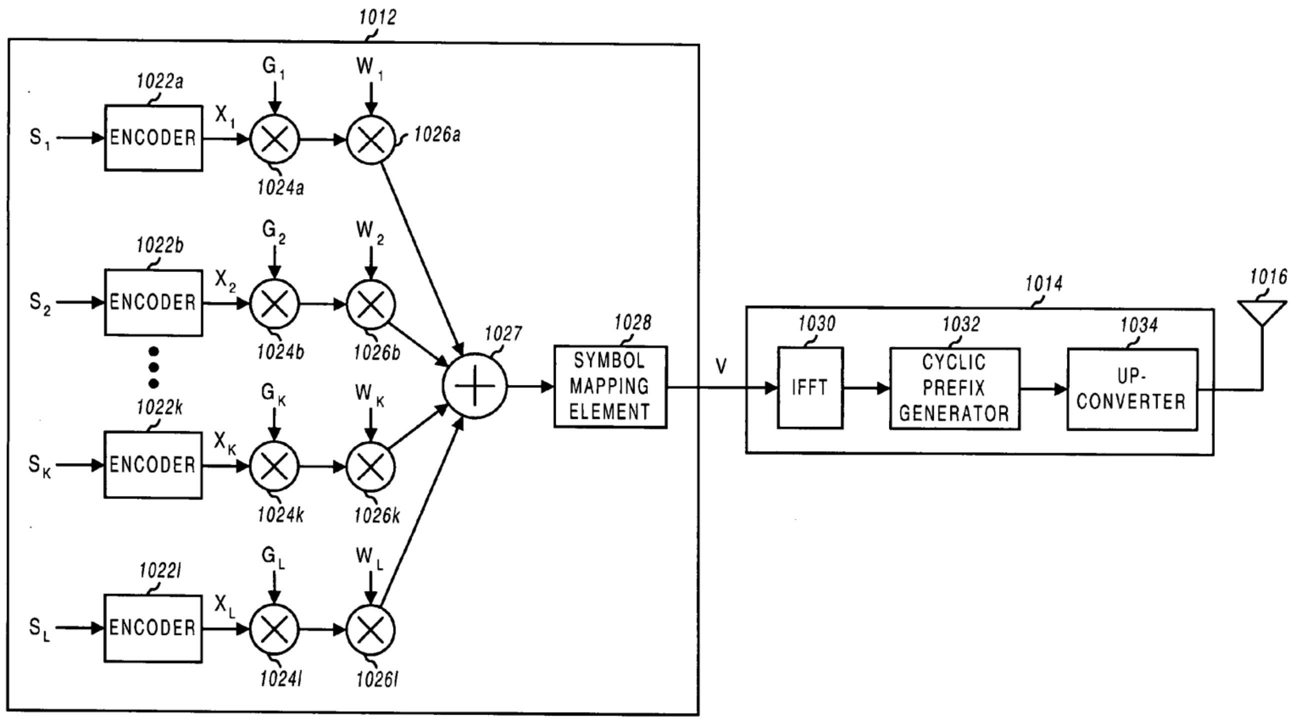
<table>
<tr><th>Claim 9 of the ’802 Patent</th><th>Prior Art Reference – Jalali</th></tr>
<tr><td></td><td>

FIG. 2

See, *e.g.*, Jalali at Figure 2.</td></tr>
</table>

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 9 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 9 of the '802 Patent	**Prior Art Reference – Jalali**
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

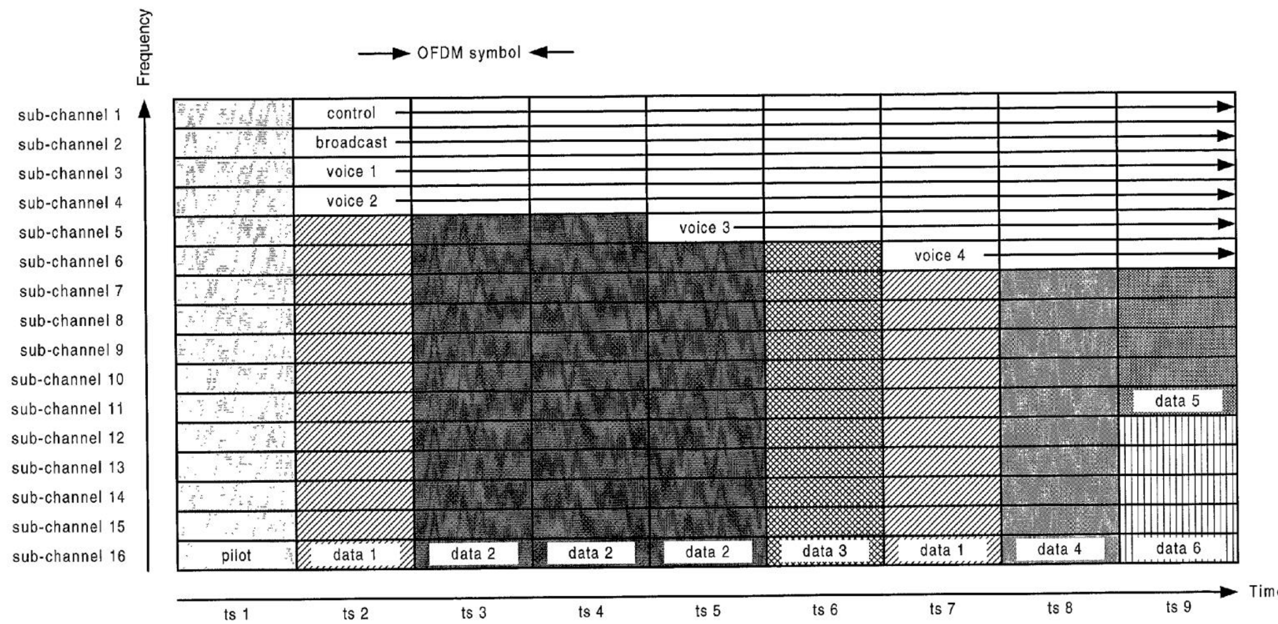
Claim 9 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

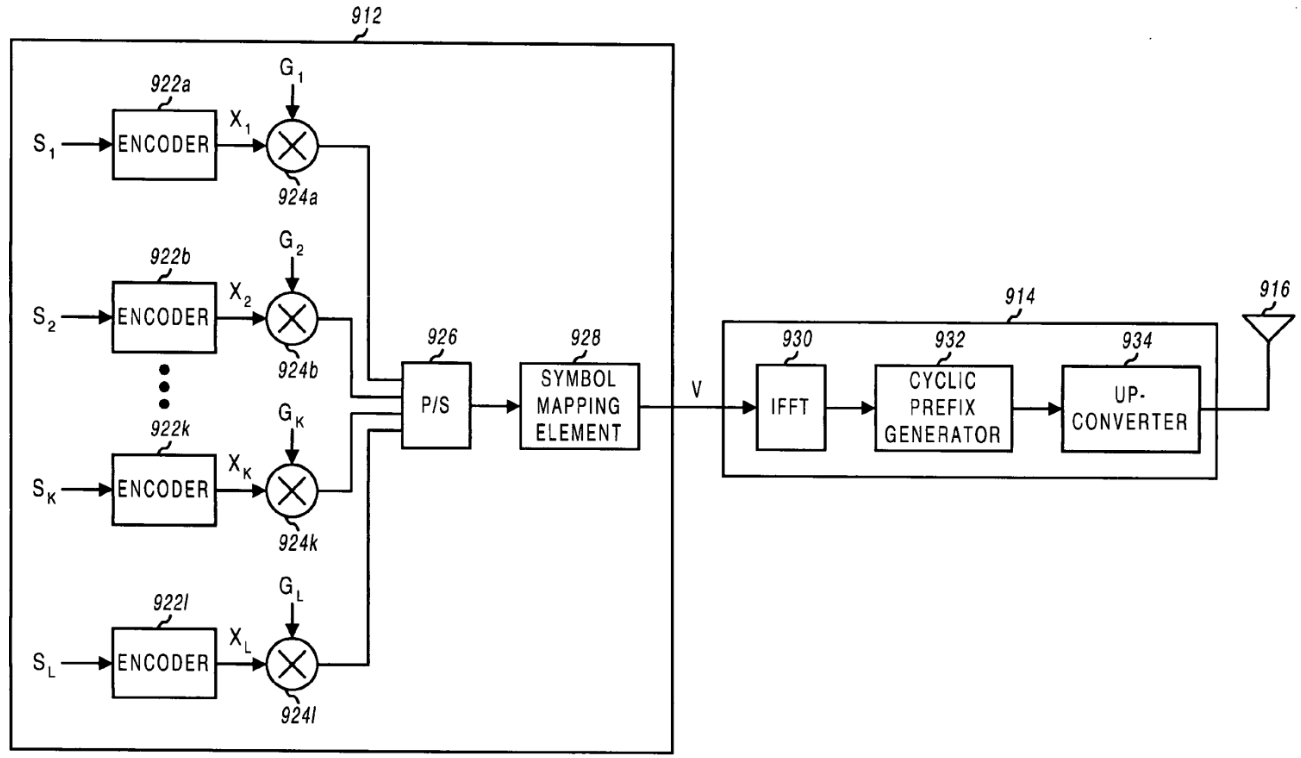
Claim 9 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

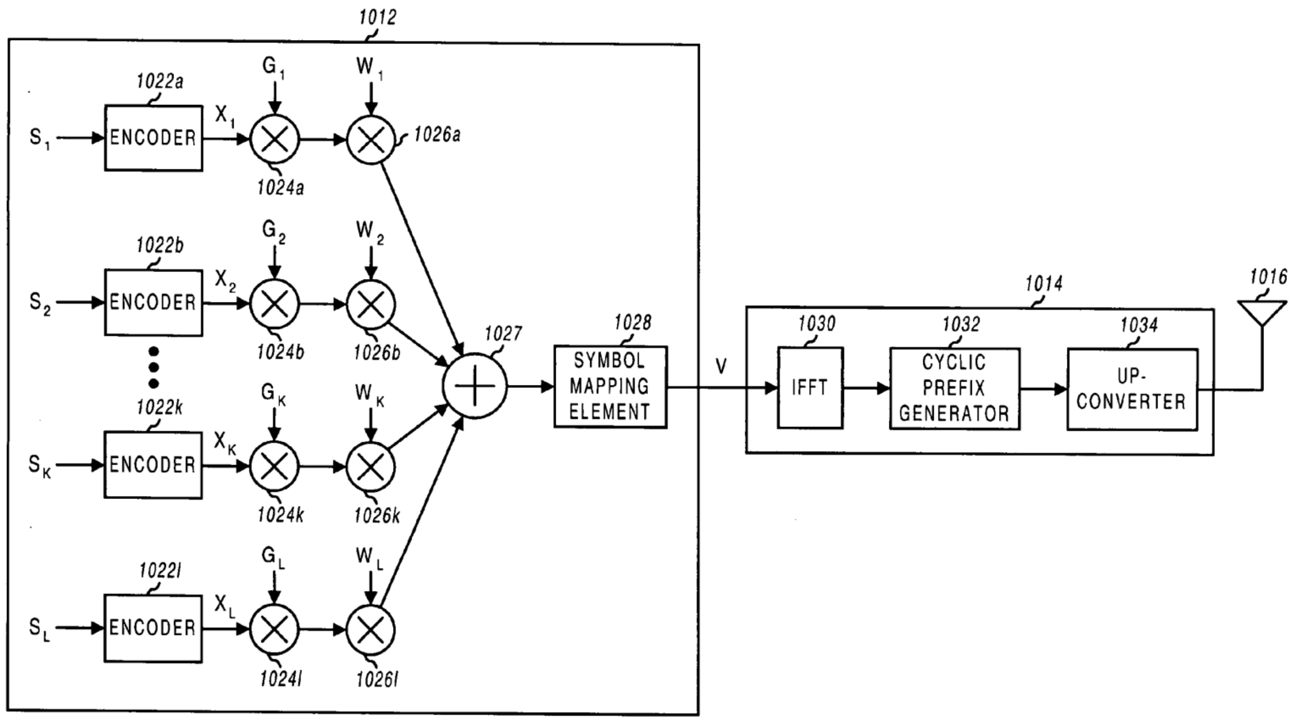
Claim 9 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
[10.1] A method of transmitting information in a wireless communication channel comprising:	To the extent the preamble is limiting, Jalali discloses “A method of transmitting information in a wireless communication channel comprising.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.2] receiving a first digital signal comprising first data to be transmitted;	Jalali discloses "receiving a first digital signal comprising first data to be transmitted." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2 *See, e.g.*, Jalali at Figure 2.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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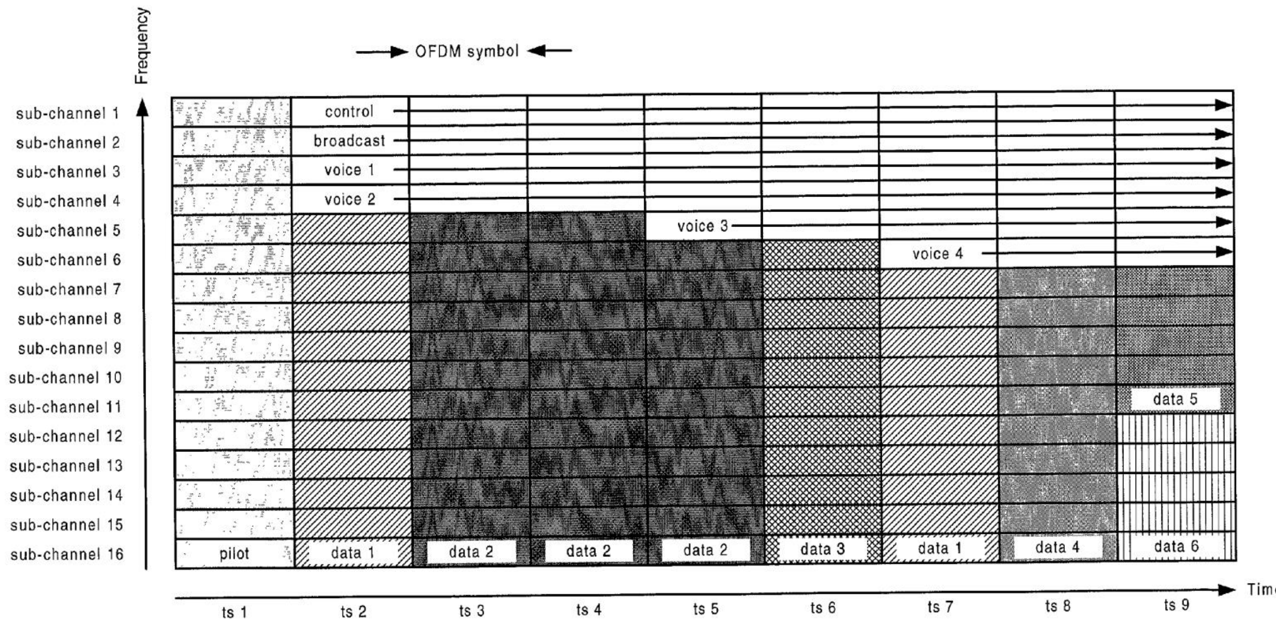
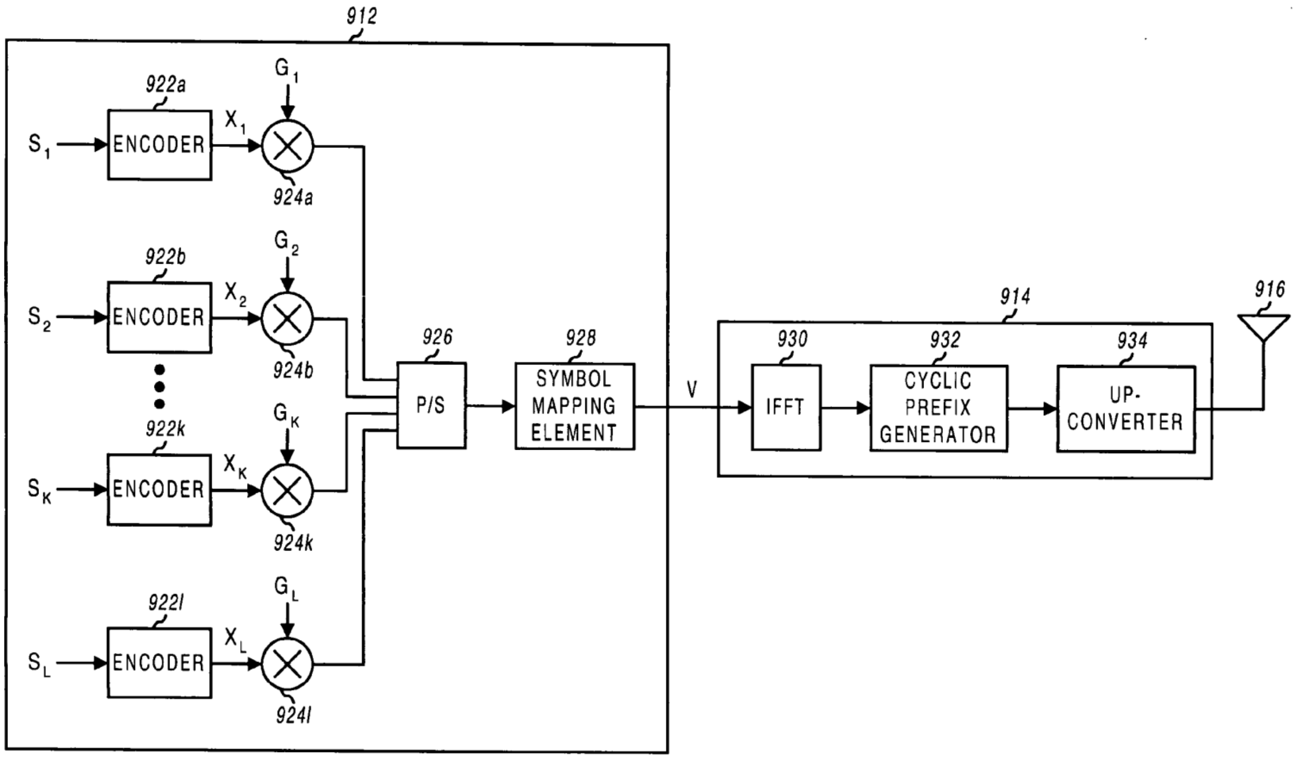
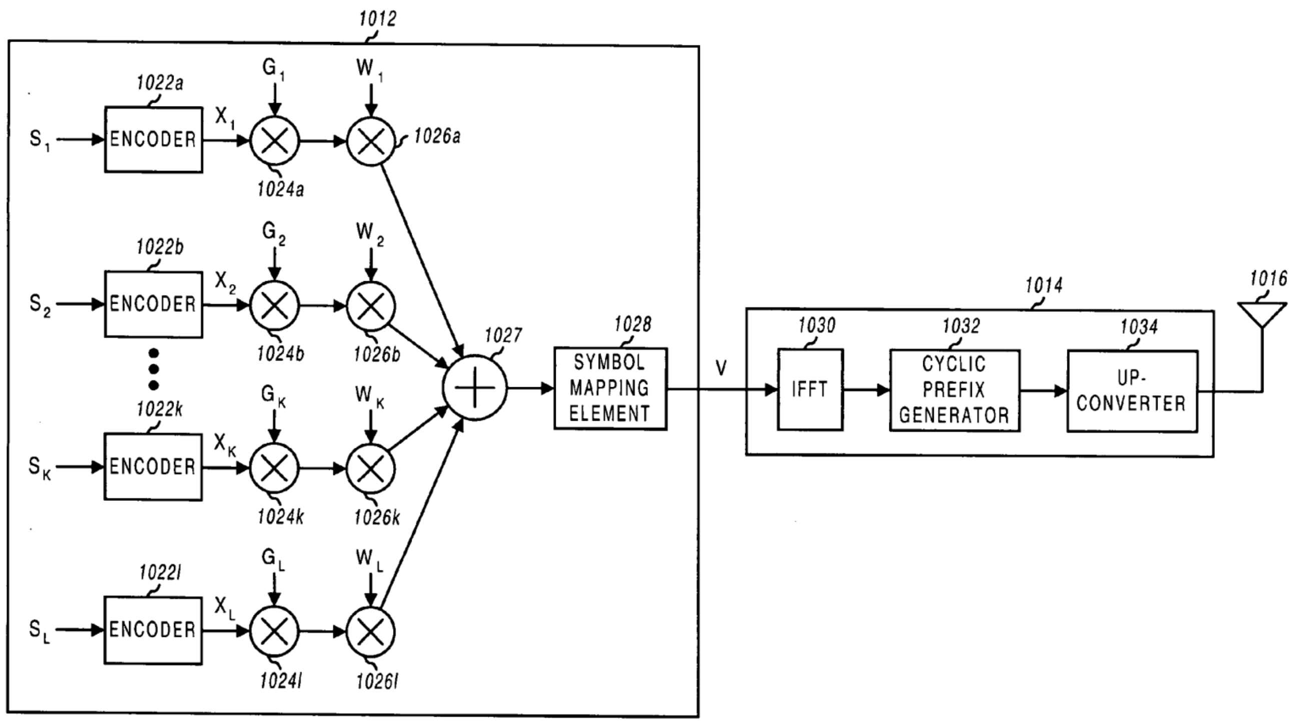
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.3] receiving a second digital signal comprising second data to be transmitted;	Jalali discloses “receiving a second digital signal comprising second data to be transmitted.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  ***FIG. 2*** *See, e.g.*, Jalali at Figure 2.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.4] converting the first digital signal into a first analog signal using a first digital-to-analog converter, the first analog signal carrying the first data across a first frequency range;.	Jalali discloses "converting the first digital signal into a first analog signal using a first digital-to-analog converter, the first analog signal carrying the first data across a first frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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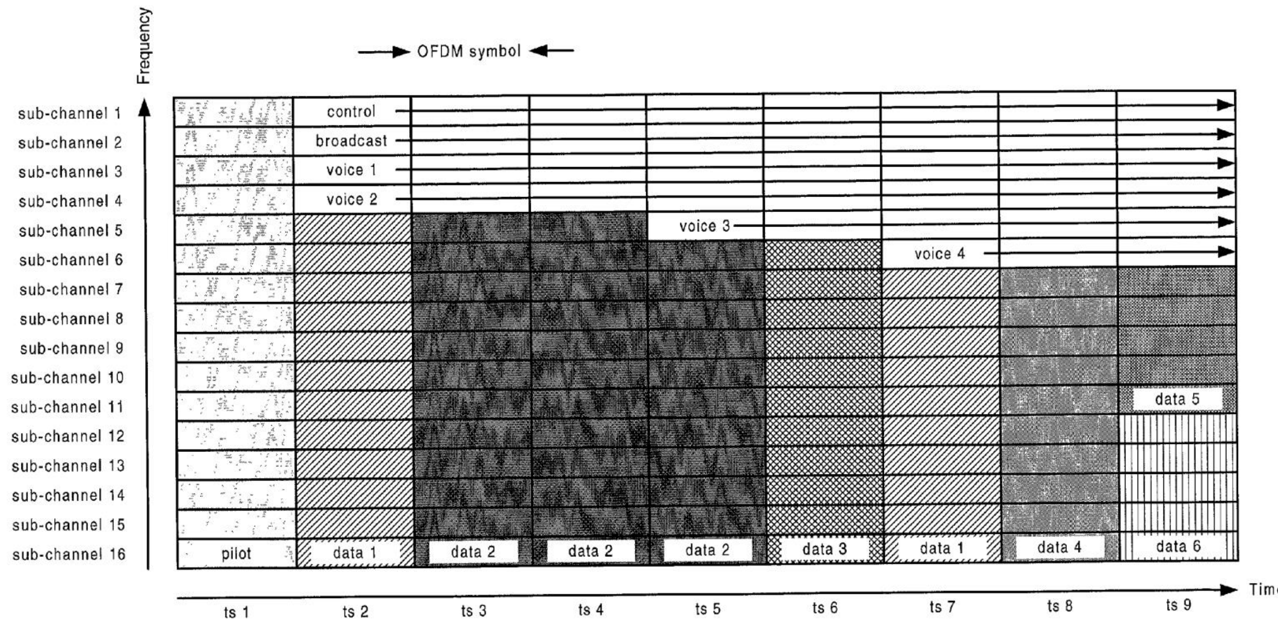
	“circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	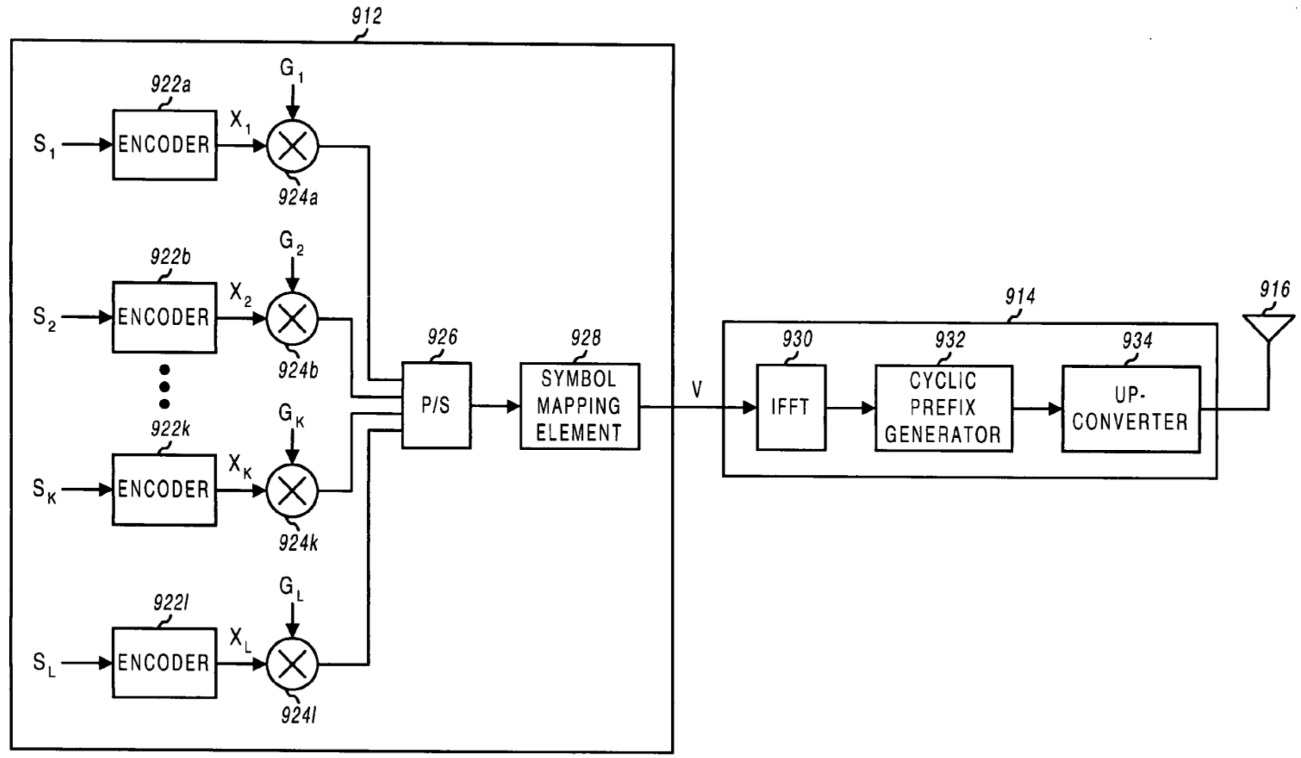 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

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	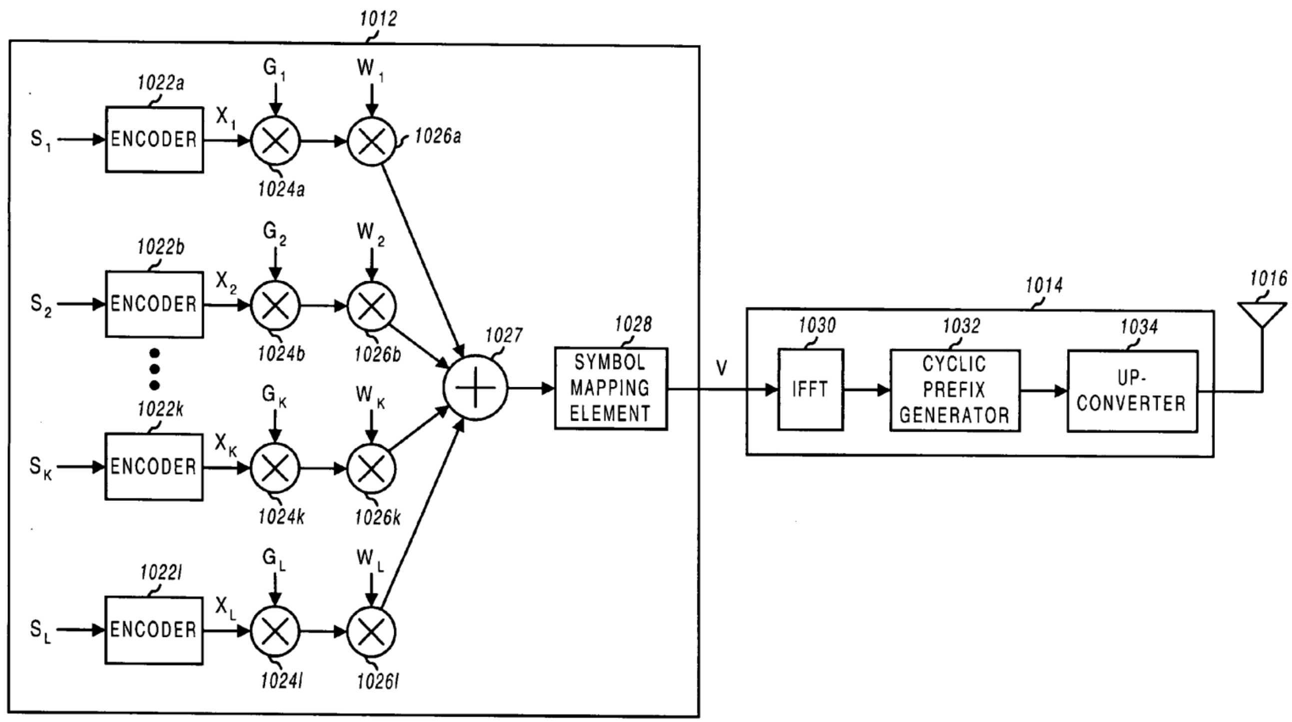 FIG. 10 *See*, *e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See*, *e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.5] converting the second digital signal into a second analog signal using a second digital-to-analog converter, the second analog signal carrying the second data across a second frequency range;	Jalali discloses "converting the second digital signal into a second analog signal using a second digital-to-analog converter, the second analog signal carrying the second data across a second frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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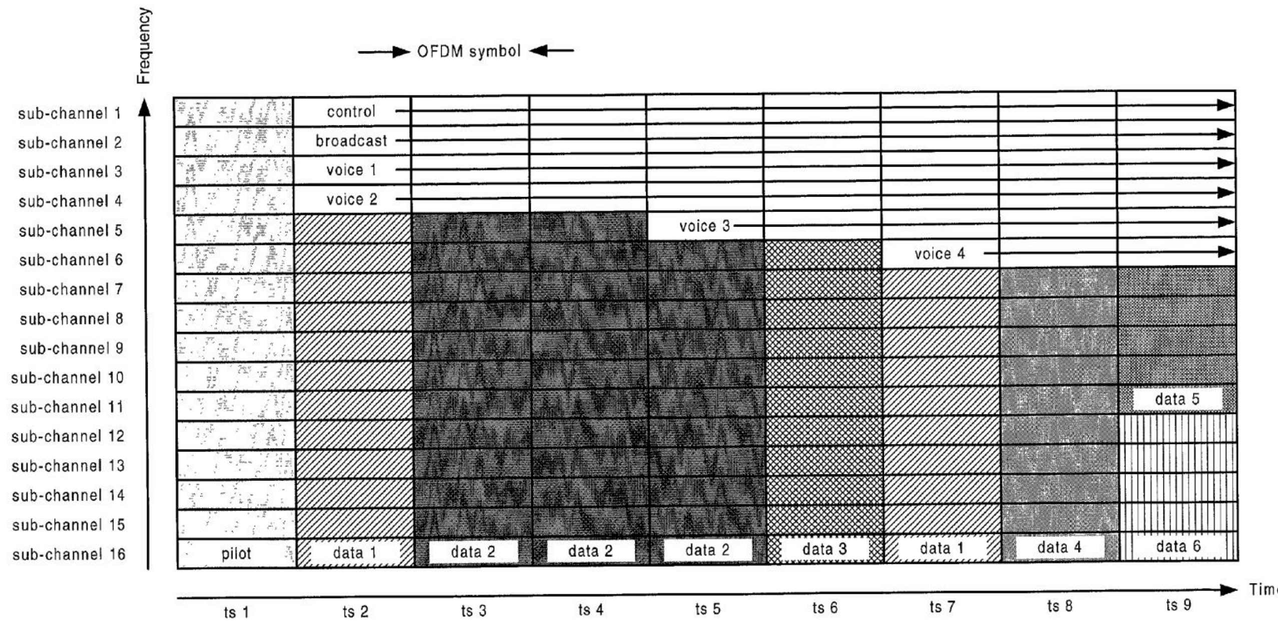
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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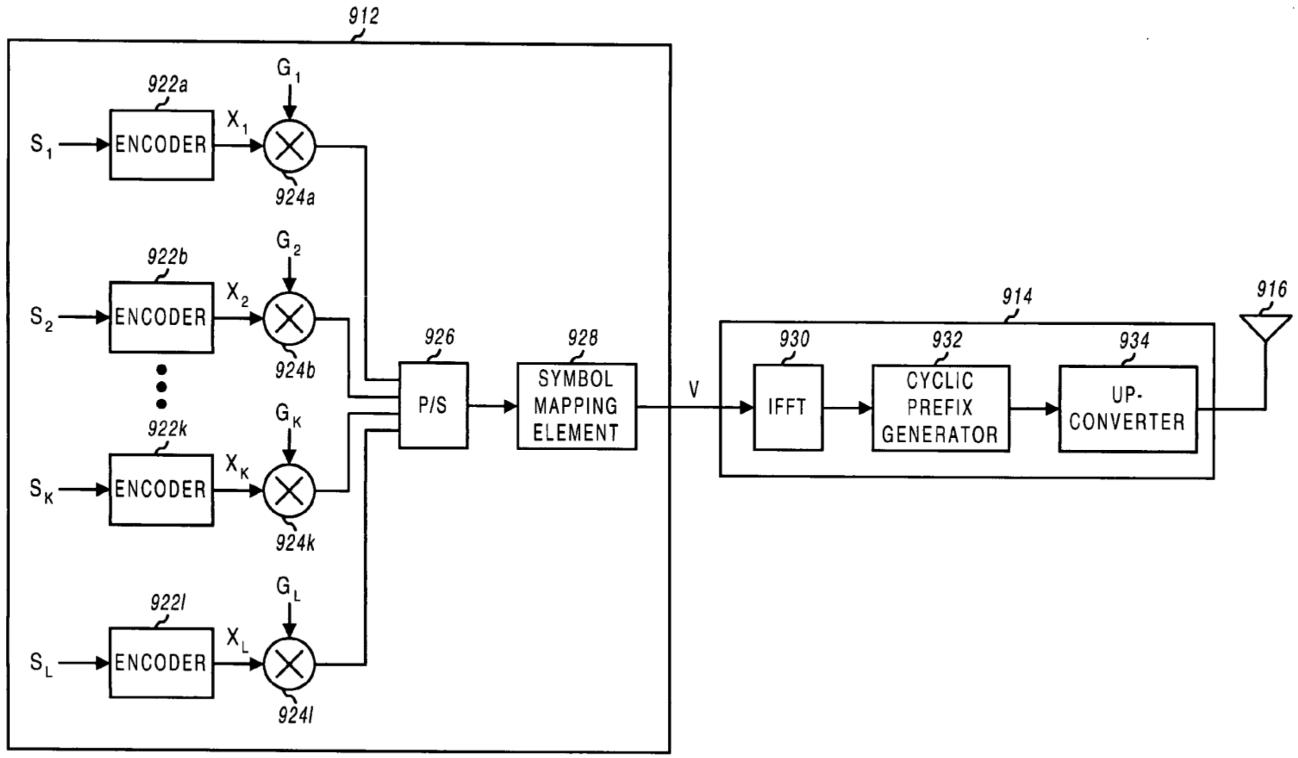
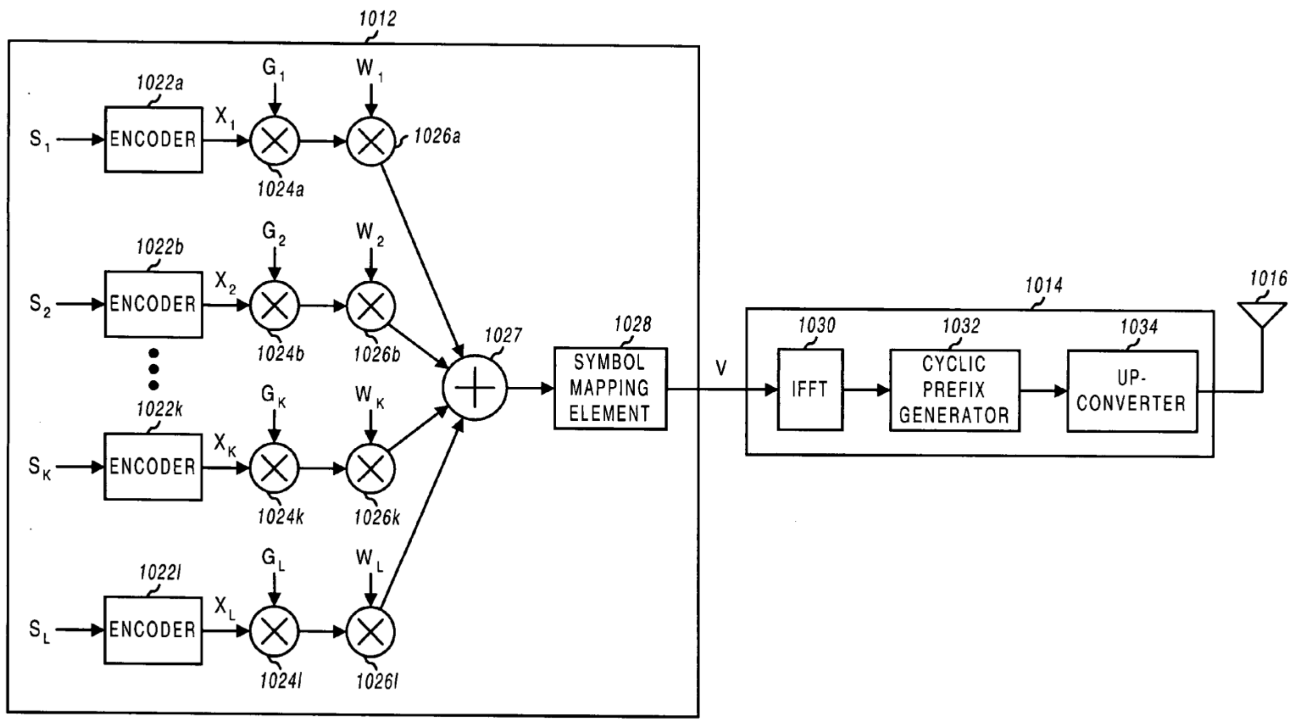
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.6] up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-converted analog signal comprises a first up-converted frequency range from the first RF center frequency minus one-half the first frequency range to the first RF center	Jalali discloses “up-converting the first analog signal to a first RF center frequency to produce a first up-converted analog signal, wherein the first up-converted analog signal comprises a first up-converted frequency range from the first RF center frequency minus one-half the first frequency range to the first RF center frequency plus one-half the first frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

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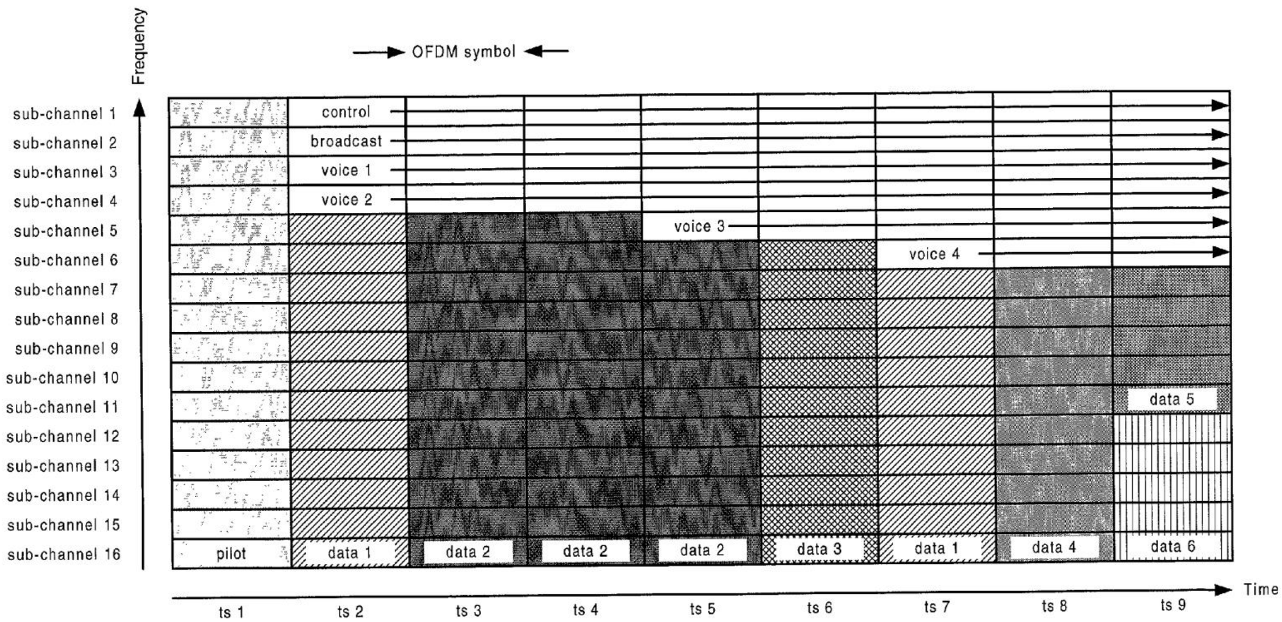
frequency plus one-half the first frequency range;	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2 *See, e.g.*, Jalali at Figure 2.

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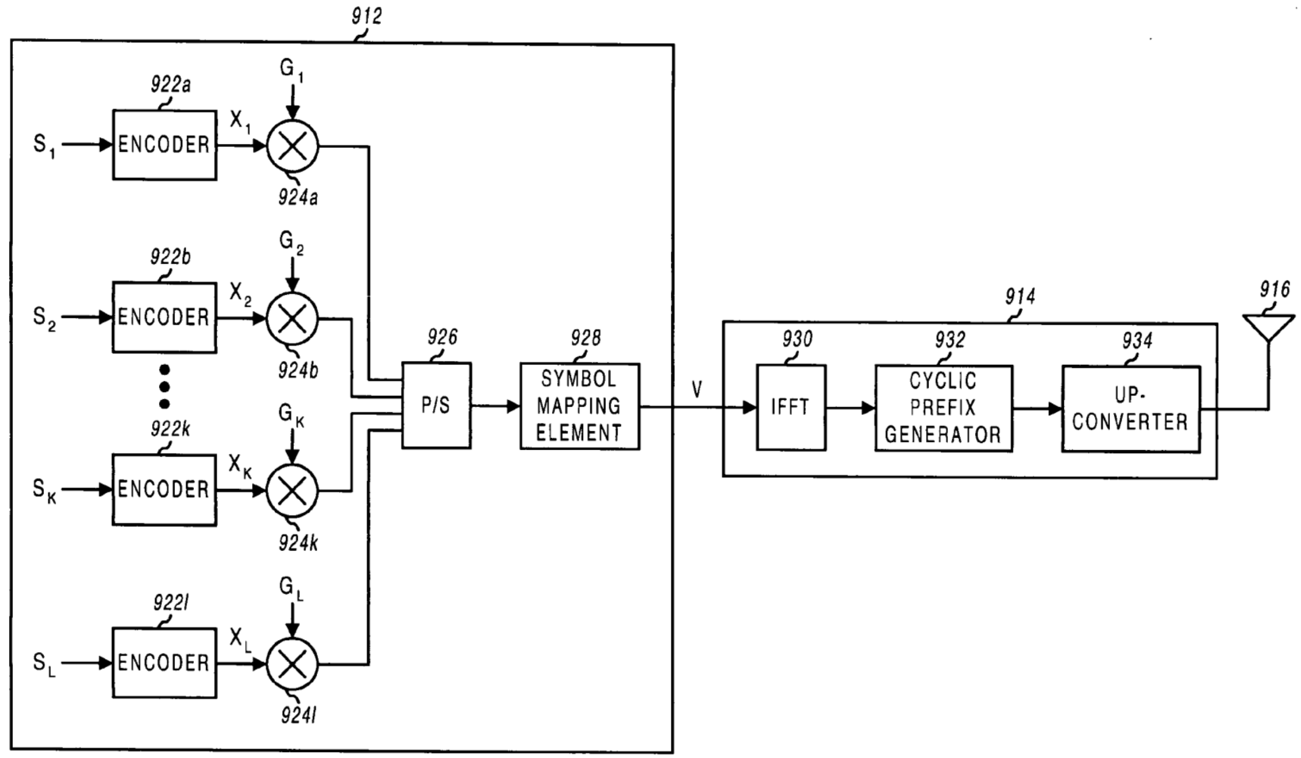
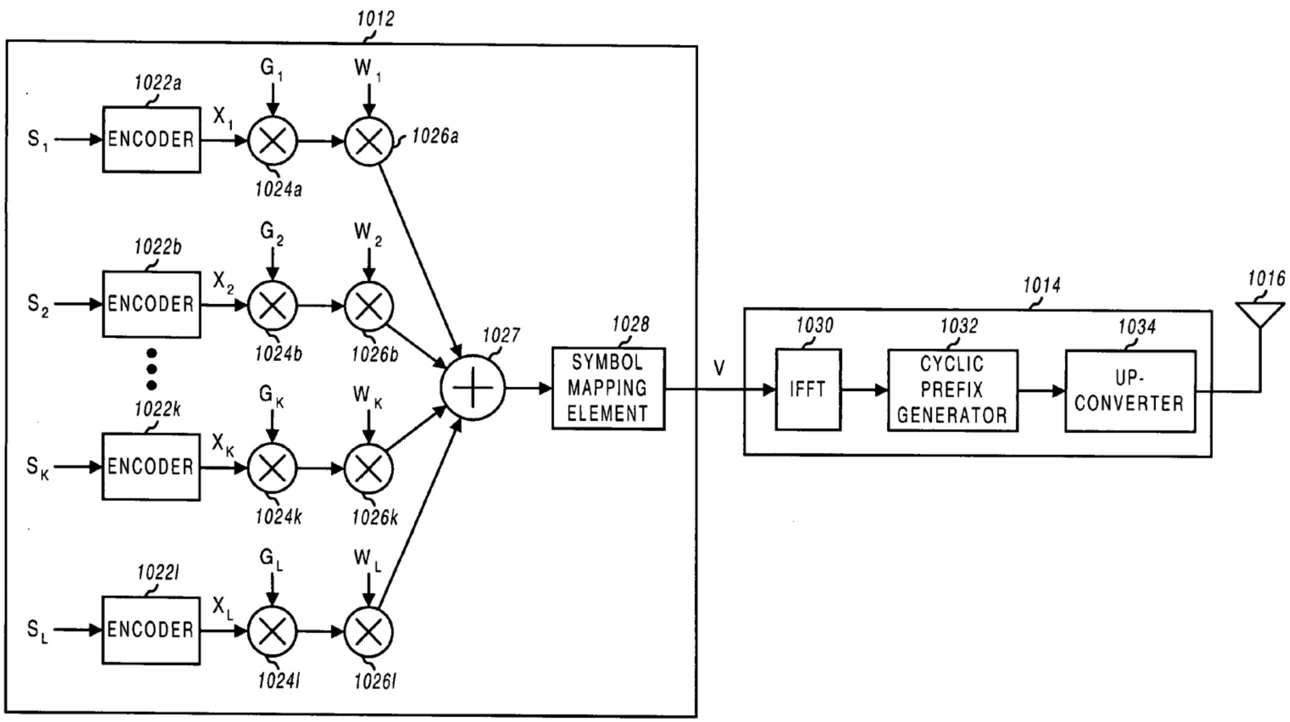
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 10 of the '802 Patent	**Prior Art Reference – Jalali**
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.7] up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal comprises a second up-converted frequency range from the second RF center frequency minus one-half the	Jalali discloses "up-converting the second analog signal to a second RF center frequency greater than the first center RF frequency to produce a second up-converted analog signal, wherein the second up-converted analog signal comprises a second up-converted frequency range from the second RF center frequency minus one-half the second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

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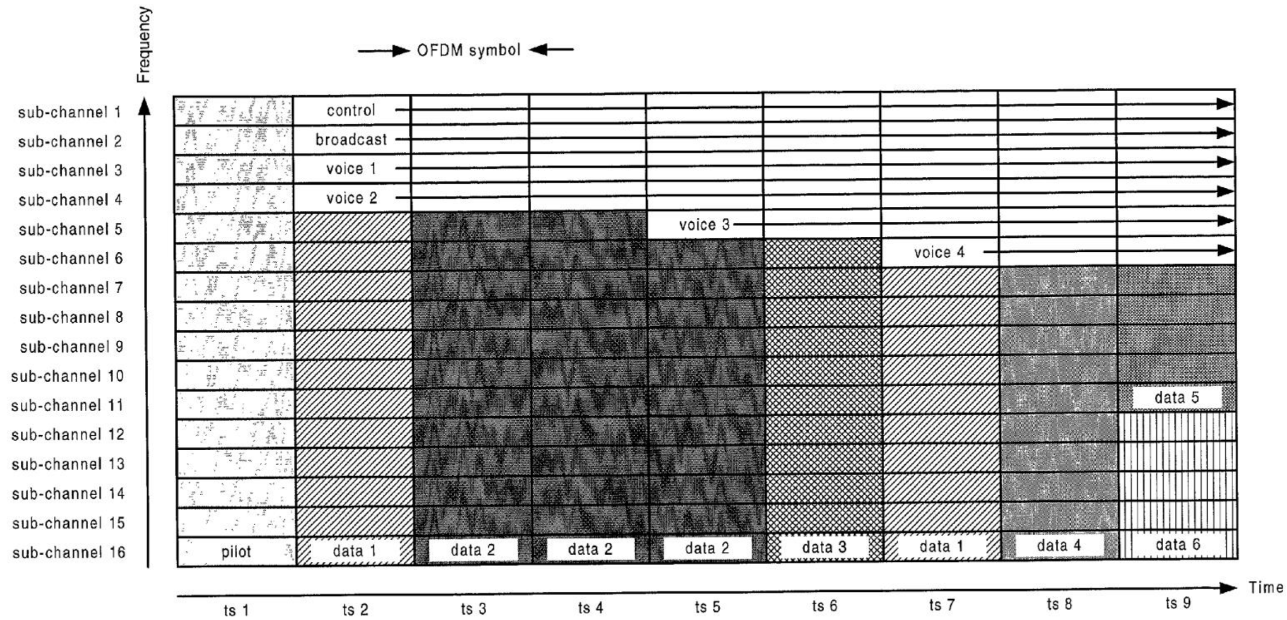
second frequency range to the second RF center frequency plus one-half the second frequency range, and wherein a frequency difference between the first RF center frequency and the second RF center frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range;	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  **FIG. 2**

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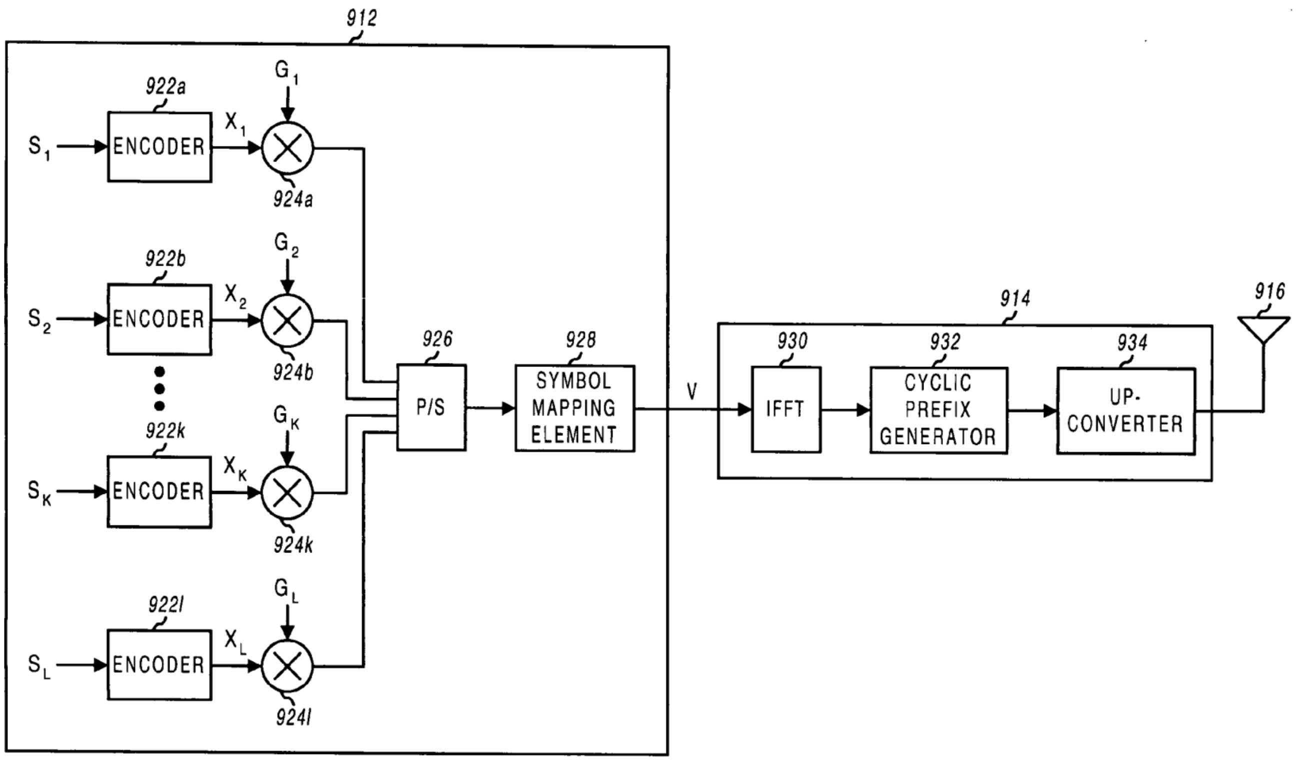
	See, e.g., Jalali at Figure 2.  *FIG. 9* *See, e.g.*, Jalali at Figure 9.

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	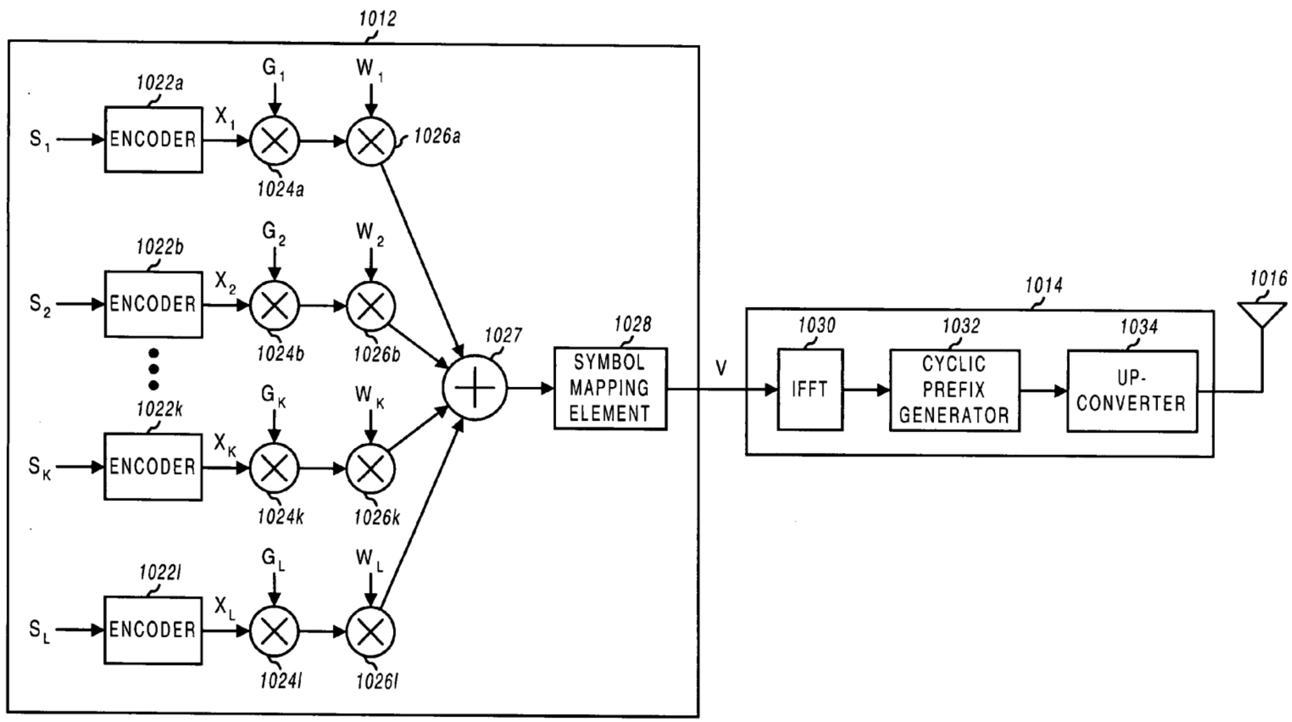 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 10 of the ’802 Patent	**Prior Art Reference – Jalali**
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.8] combining the first up-converted analog signal and the second up-converted analog signal to produce a combined up-converted signal;	Jalali discloses "combining the first up-converted analog signal and the second up-converted analog signal to produce a combined up-converted signal." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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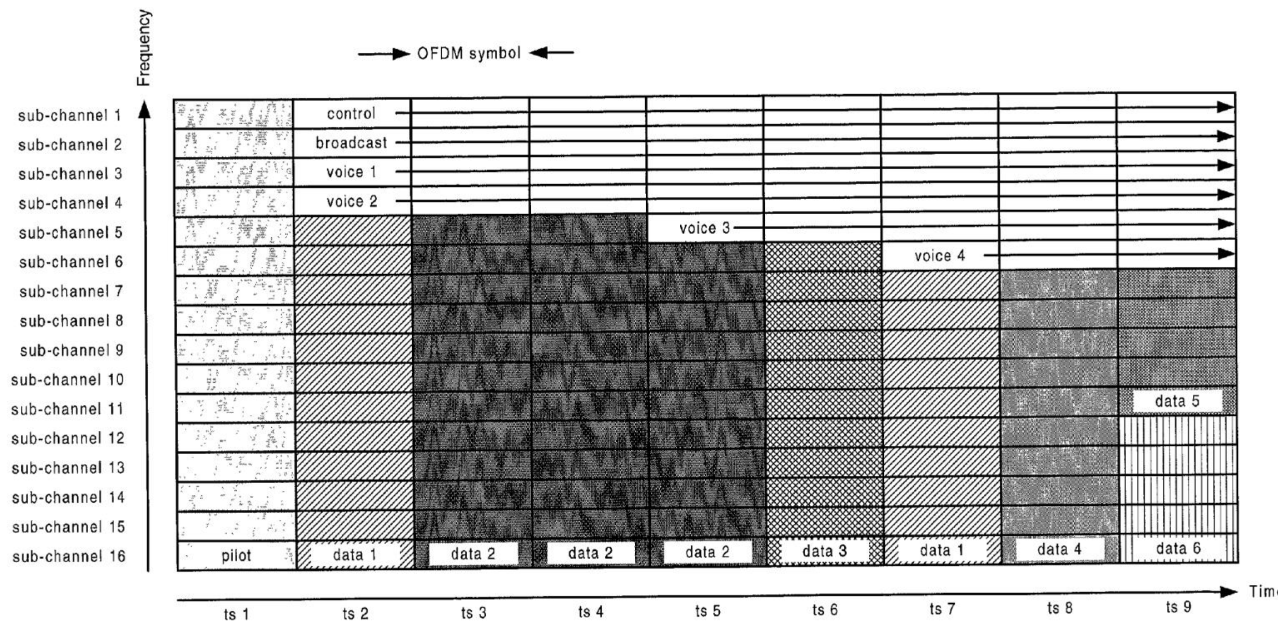
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	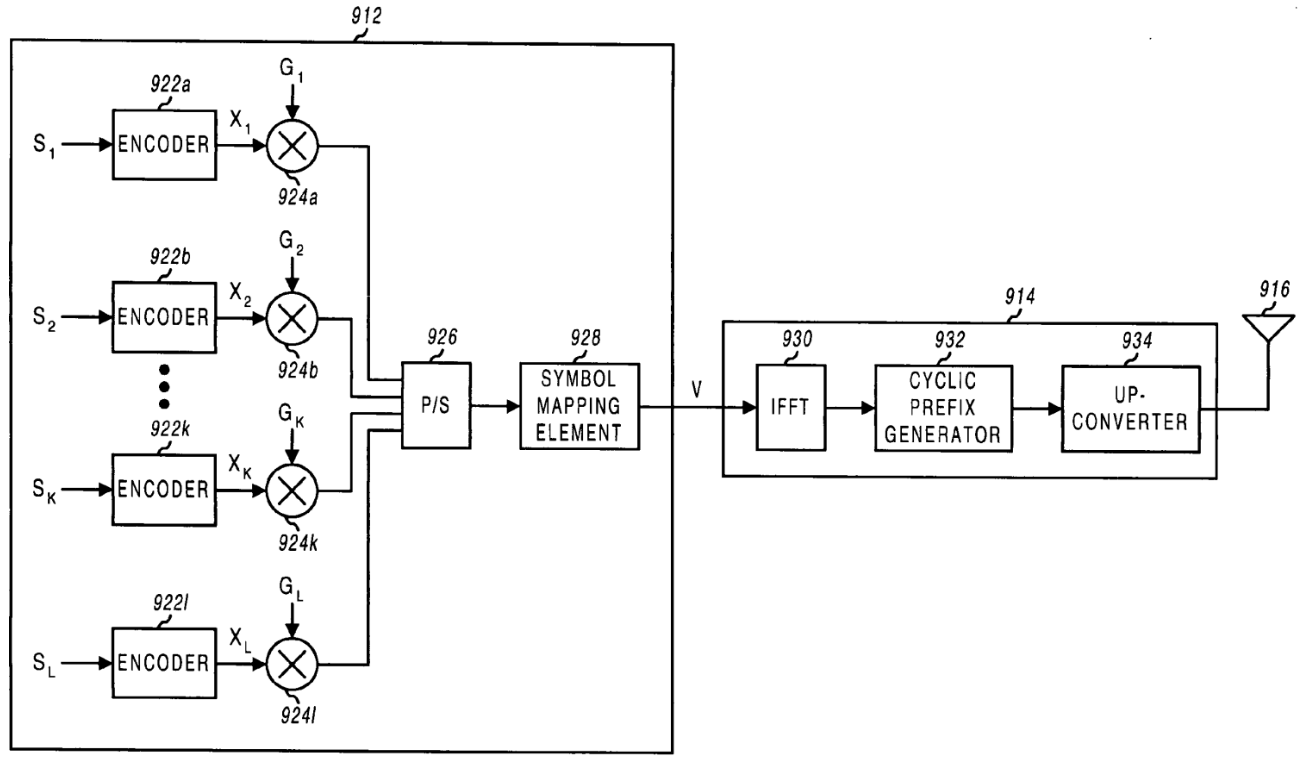 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

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	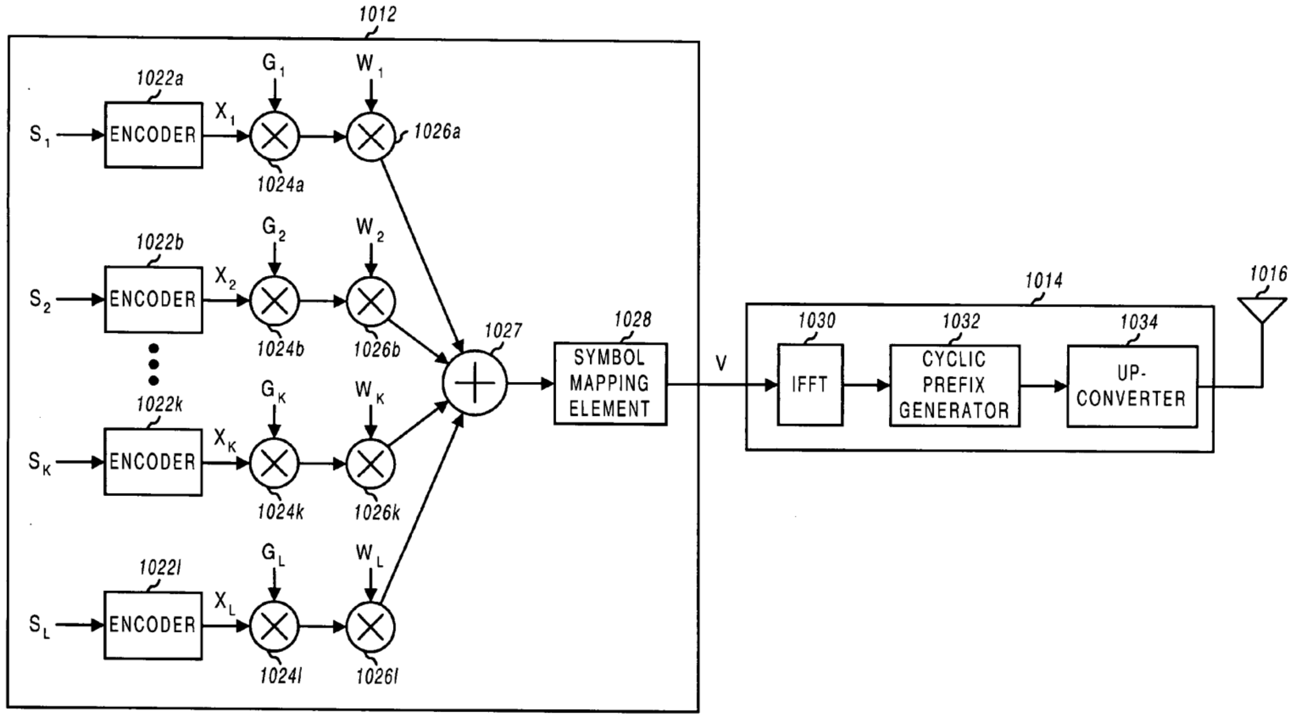 FIG. 10 *See*, *e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See*, *e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the ’802 Patent	**Prior Art Reference – Jalali**
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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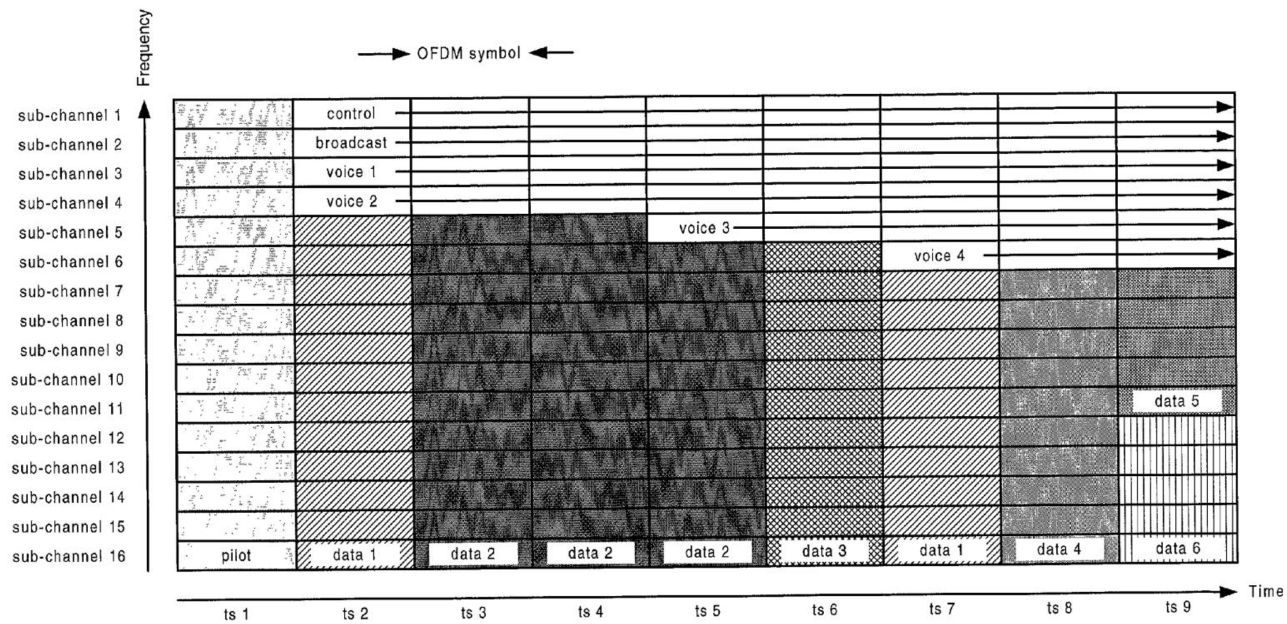
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.9] amplifying the combined up-converted signal in a power amplifier resulting in an amplified combined up-converted signal; and	Jalali discloses "amplifying the combined up-converted signal in a power amplifier resulting in an amplified combined up-converted signal." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  *FIG. 2* *See*, *e.g.*, Jalali at Figure 2.

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	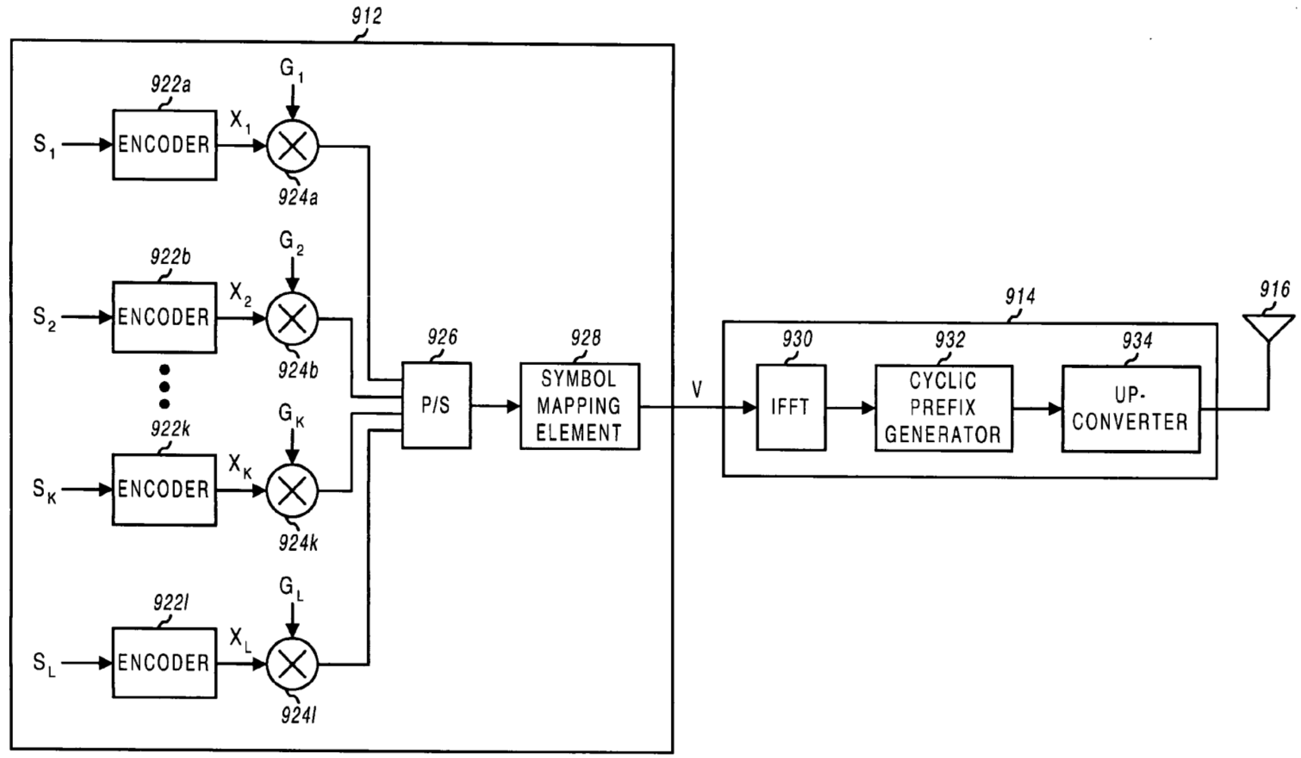 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

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	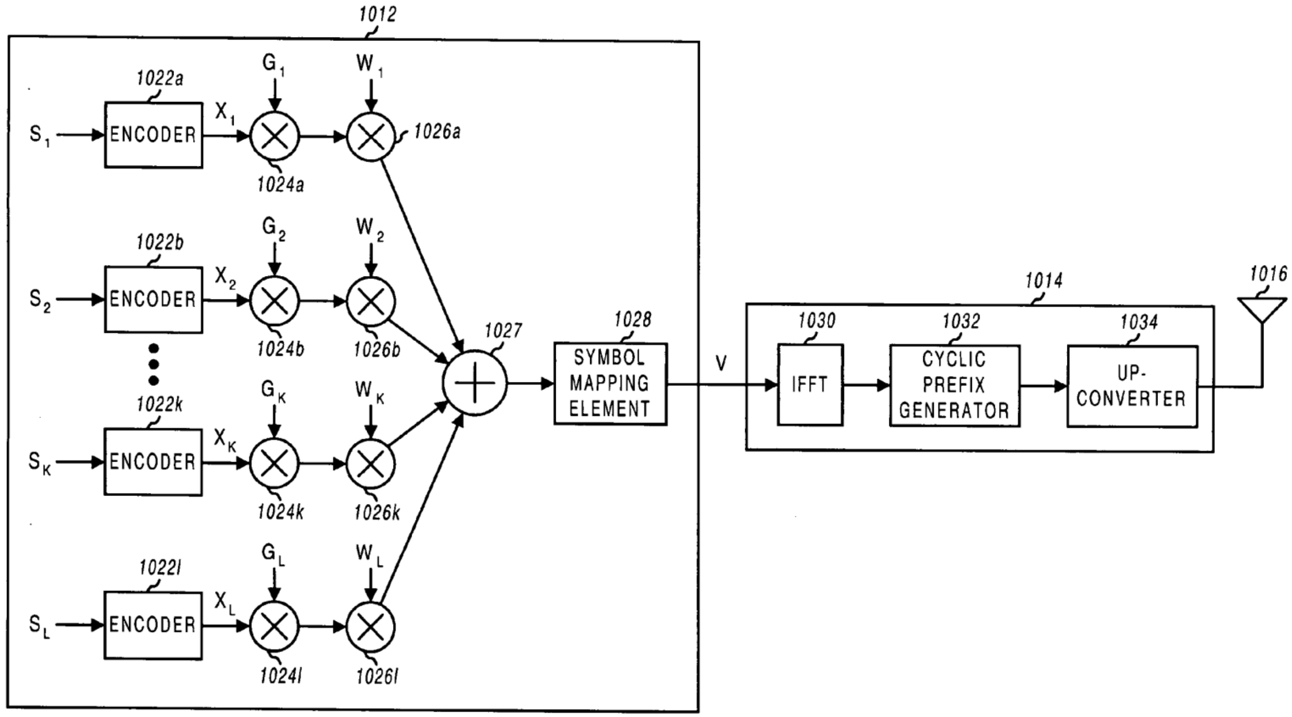 *FIG. 10* *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.10] transmitting the amplified combined up-converted signal on a first antenna,	Jalali discloses “transmitting the amplified combined up-converted signal on a first antenna.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM

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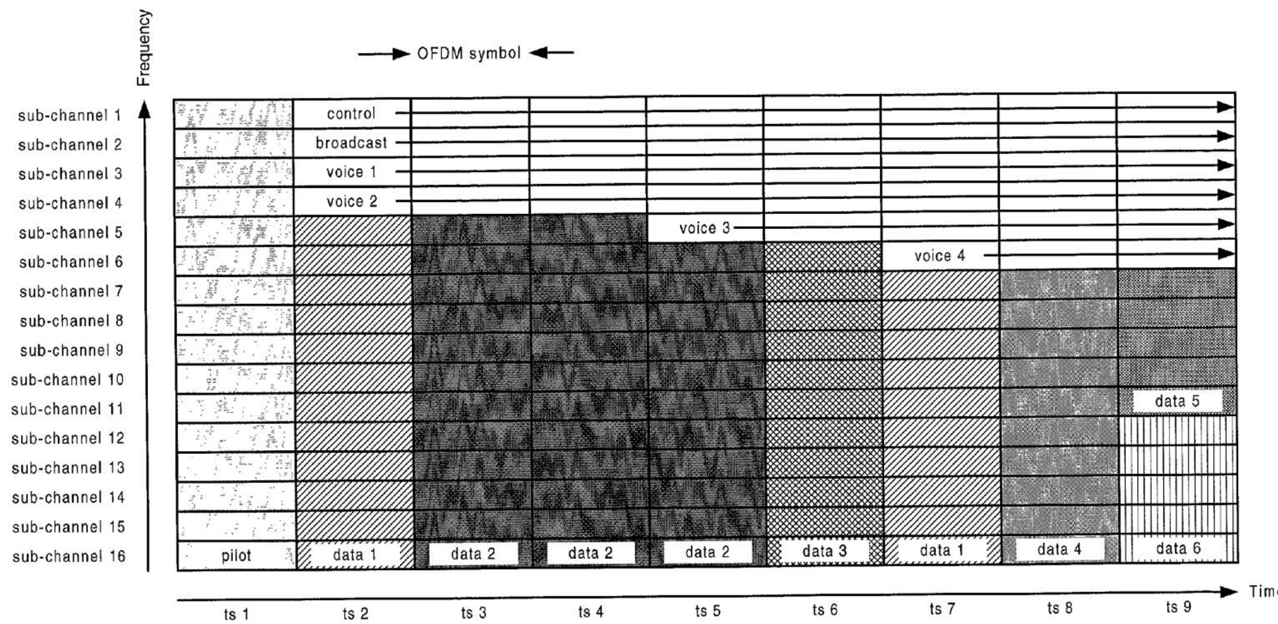
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	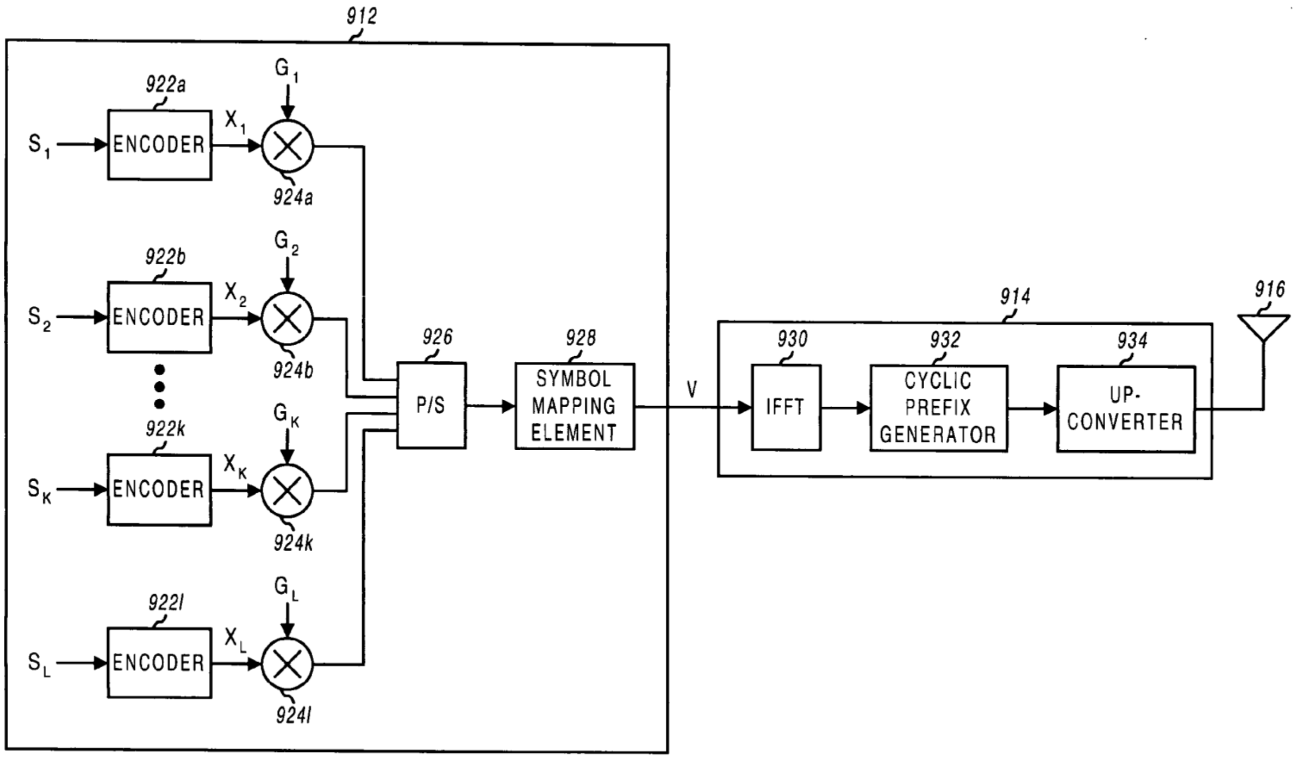 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

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	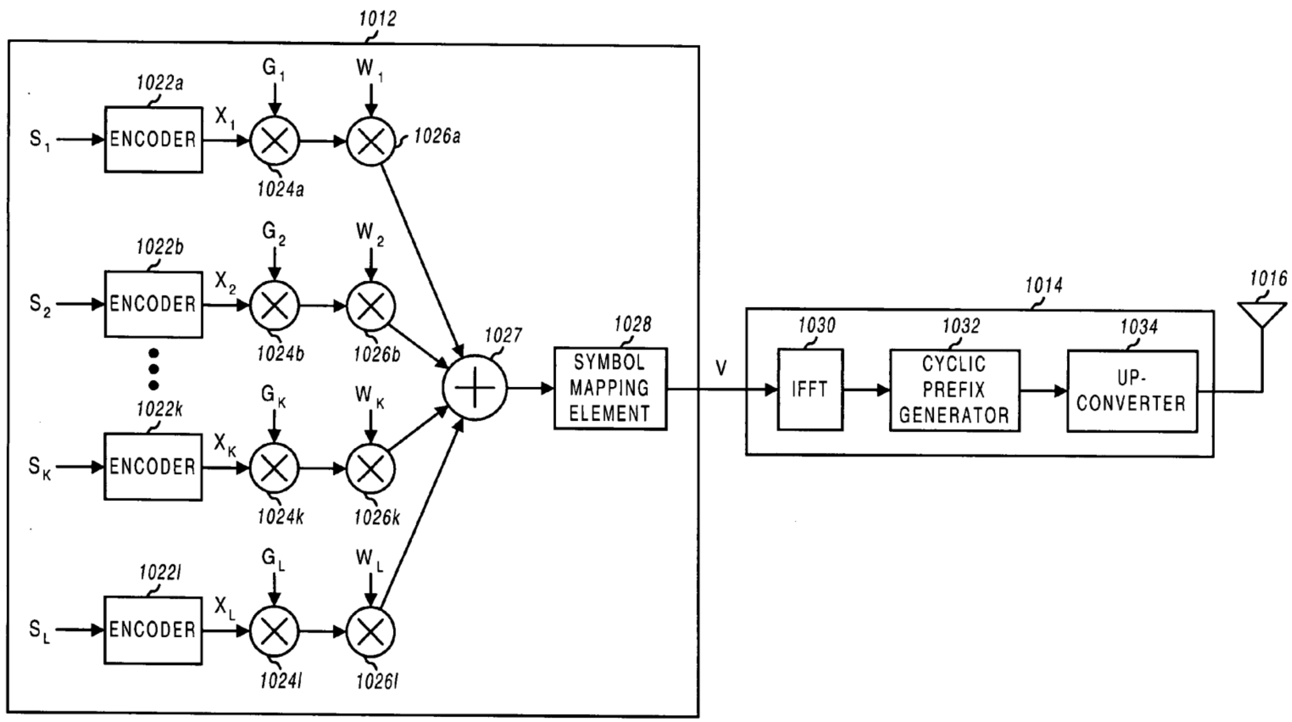 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[10.11] wherein the bandwidth of said power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range.	Jalali discloses “wherein the bandwidth of said power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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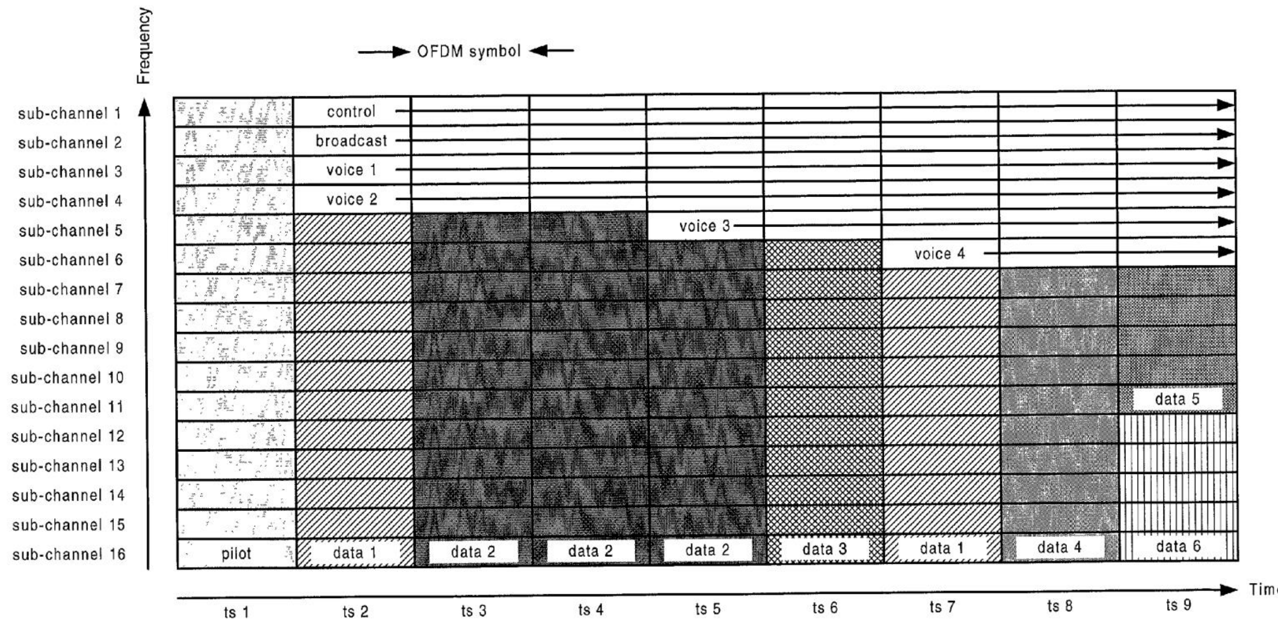
	“circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2 *See, e.g.*, Jalali at Figure 2.

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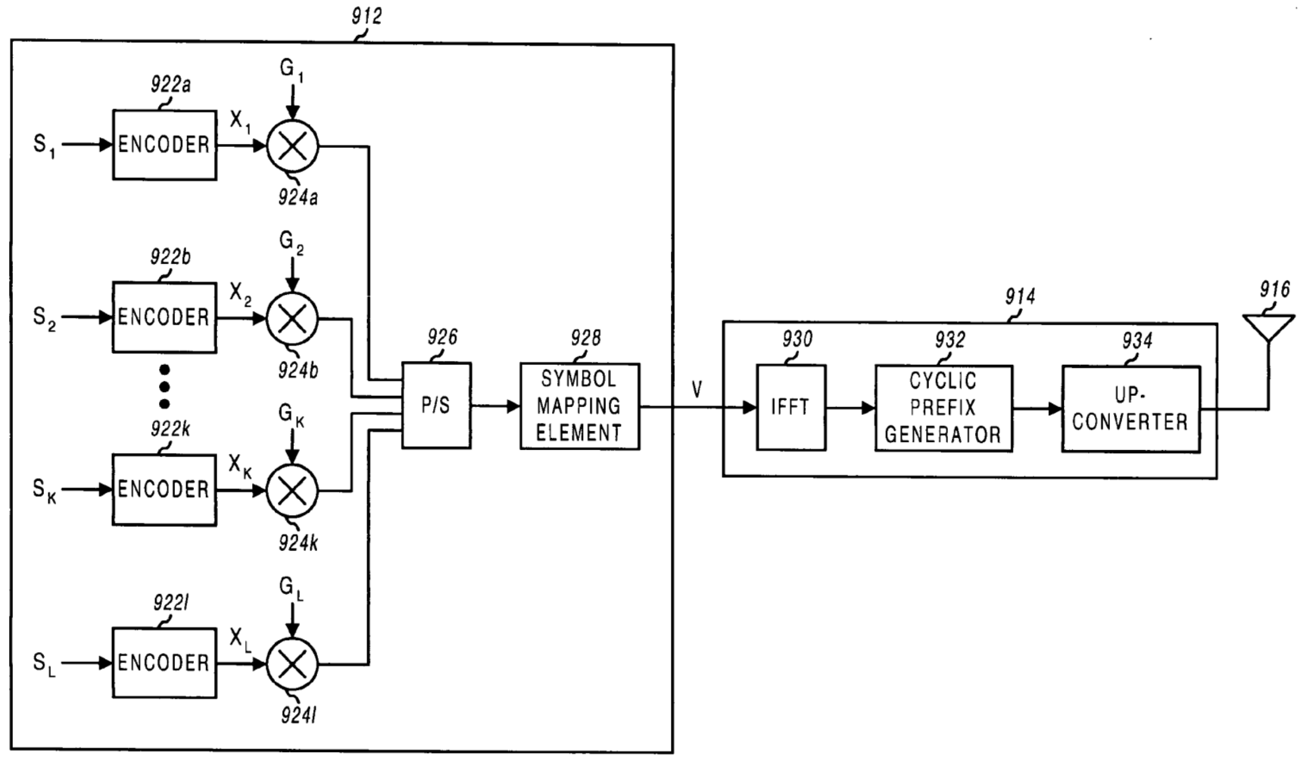
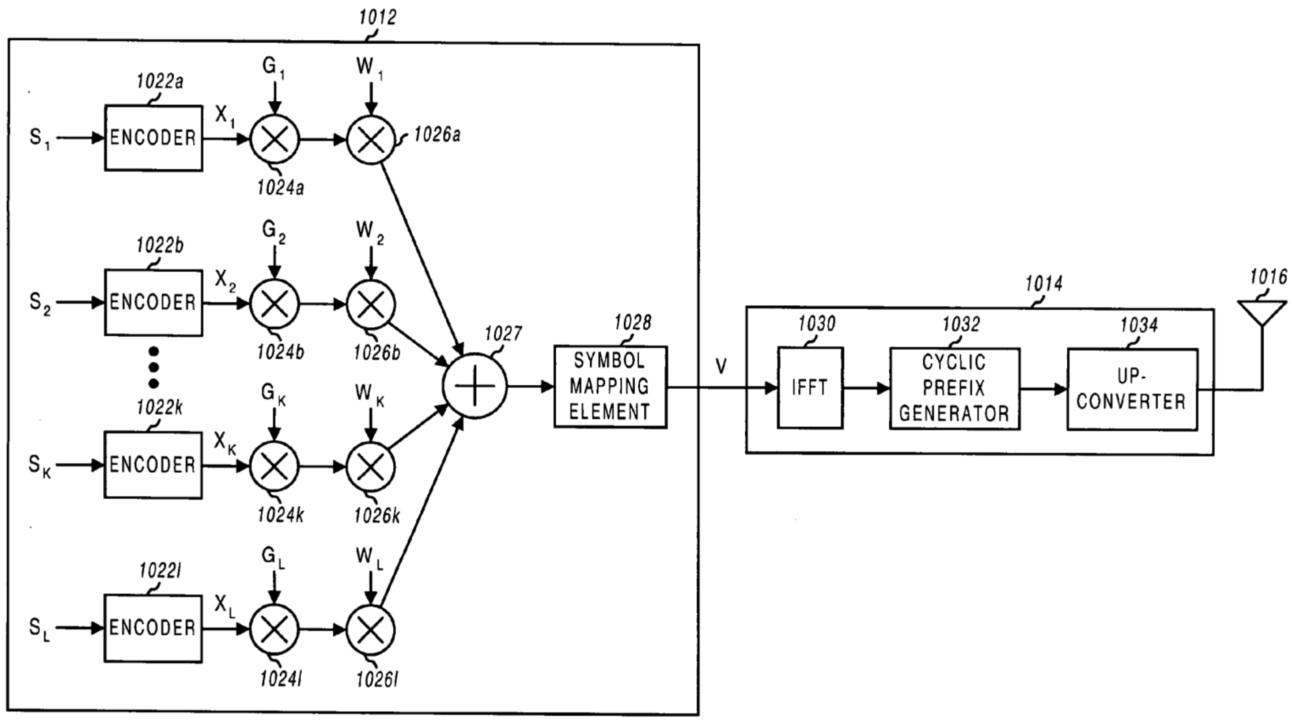
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	 **FIG. 10** *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

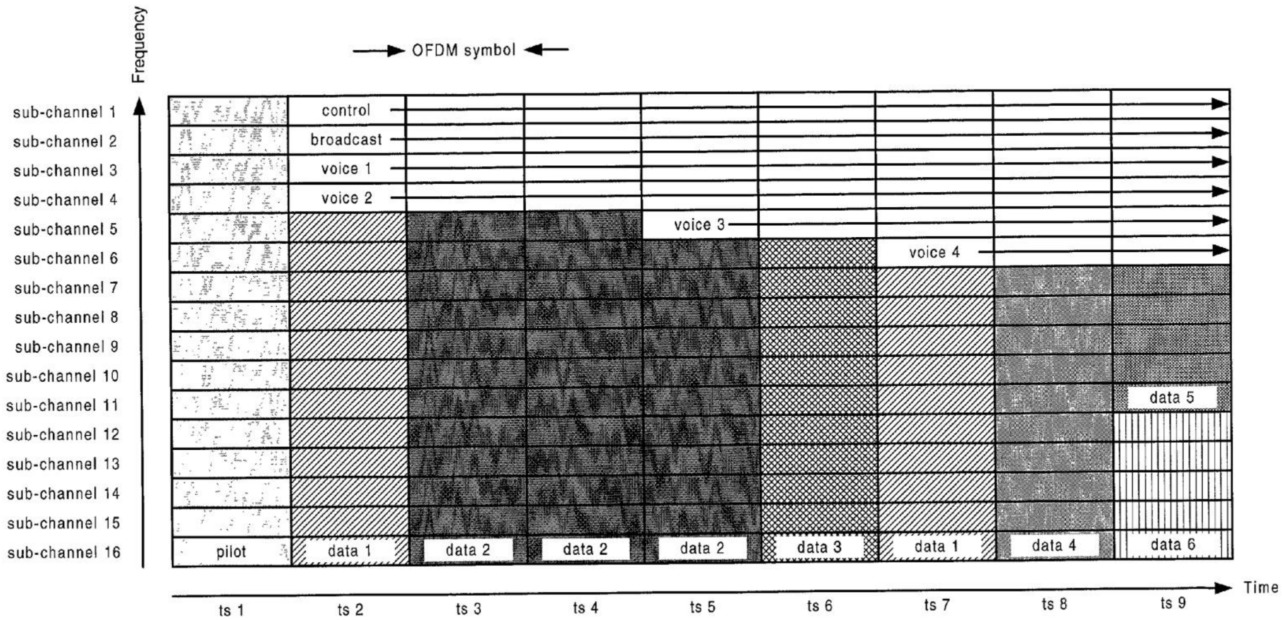
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

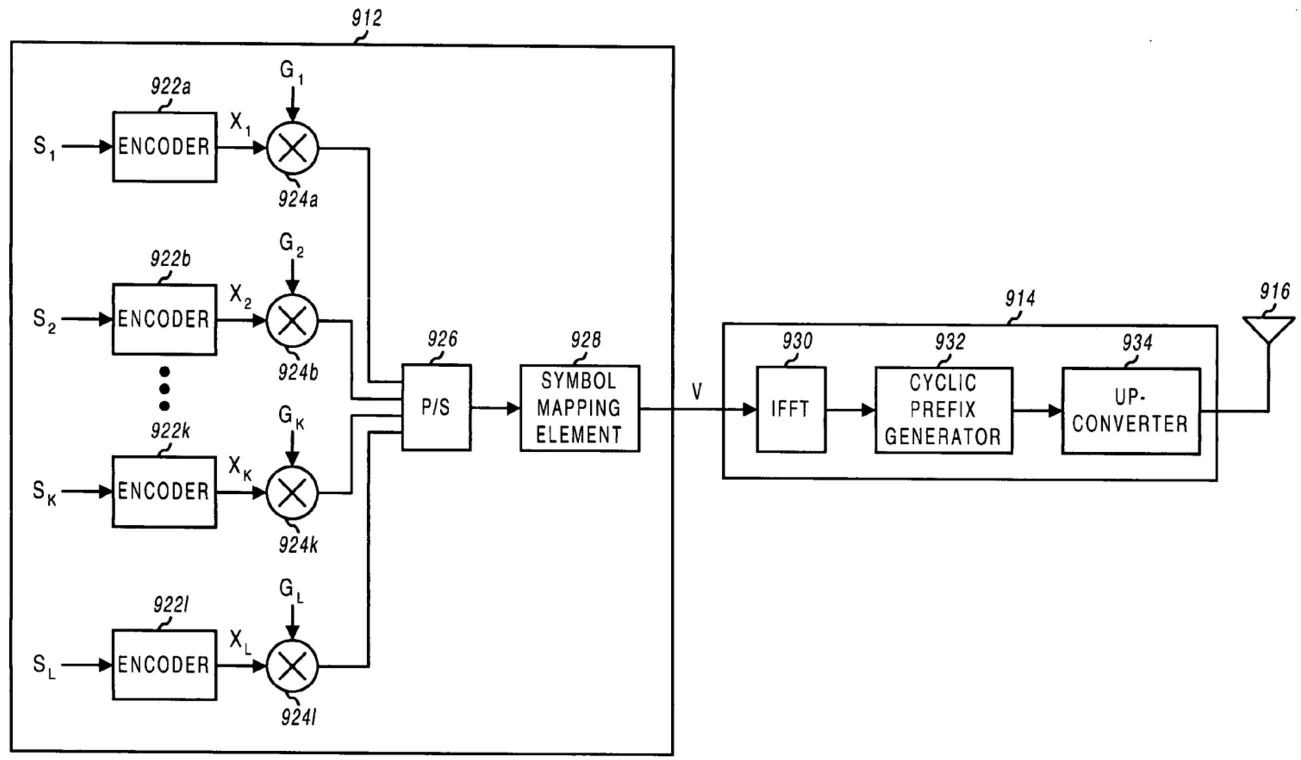
Claim 10 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

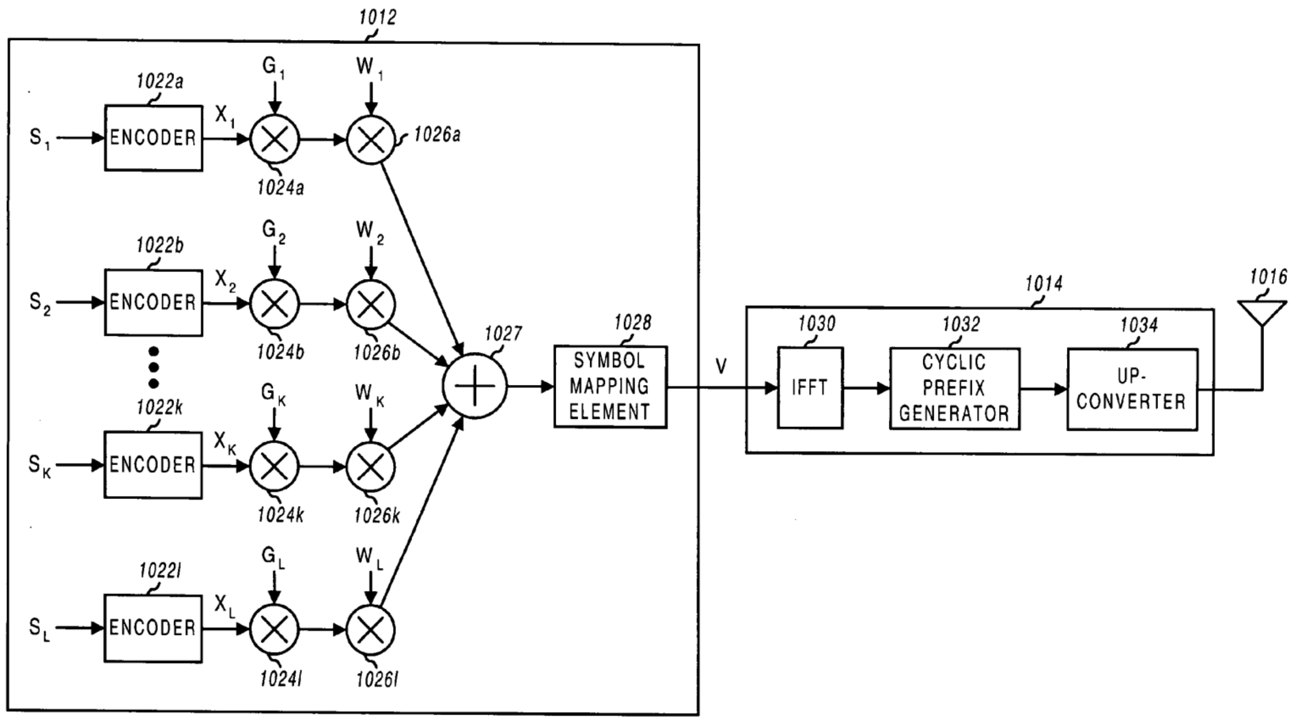
Claim 10 of the '802 Patent	**Prior Art Reference – Jalali**
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 10 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 13 of the ’802 Patent	Prior Art Reference – Jalali
[13.1] The method of claim 10	Jalali discloses all the elements of claim 10 for all the reasons provided above.
[13.2] wherein the first digital signal is encoded using a first wireless protocol and the second digital signal is encoded using a second wireless protocol.	Jalali discloses “wherein the first digital signal is encoded using a first wireless protocol and the second digital signal is encoded using a second wireless protocol.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2

Claim 13 of the ’802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	 **FIG. 10** *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

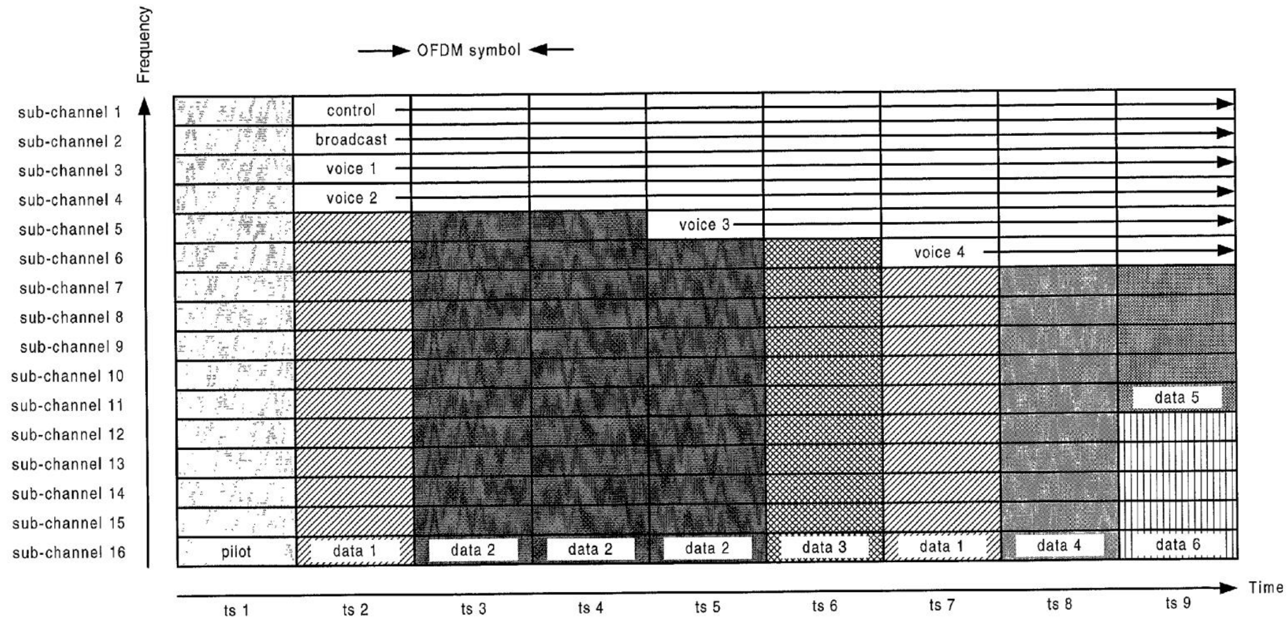
Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 13 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 13 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 14 of the ’802 Patent	Prior Art Reference – Jalali
[14.1] The method of claim 10	Jalali discloses all the elements of claim 10 for all the reasons provided above.
[14.2] wherein the second data is the same as the first data, the method further comprising:	Jalali discloses “wherein the second data is the same as the first data, the method further comprising.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2*

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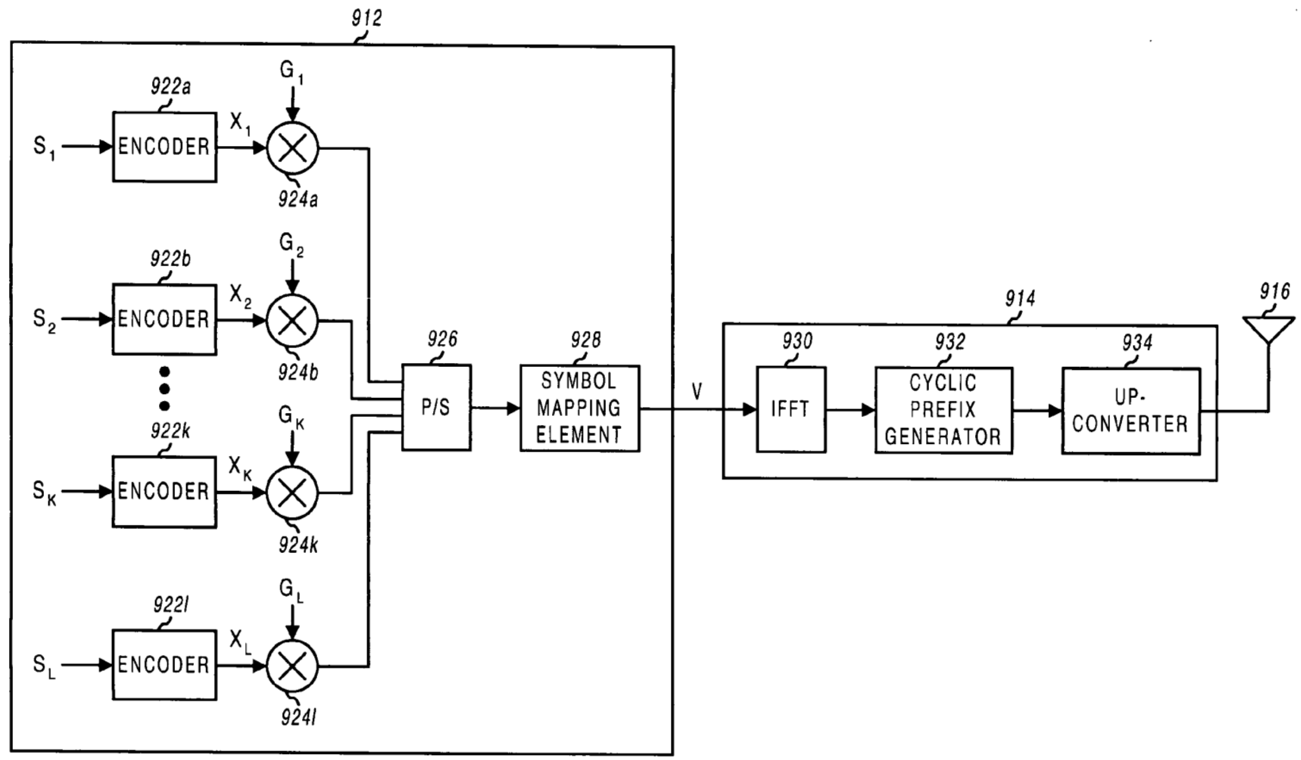
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

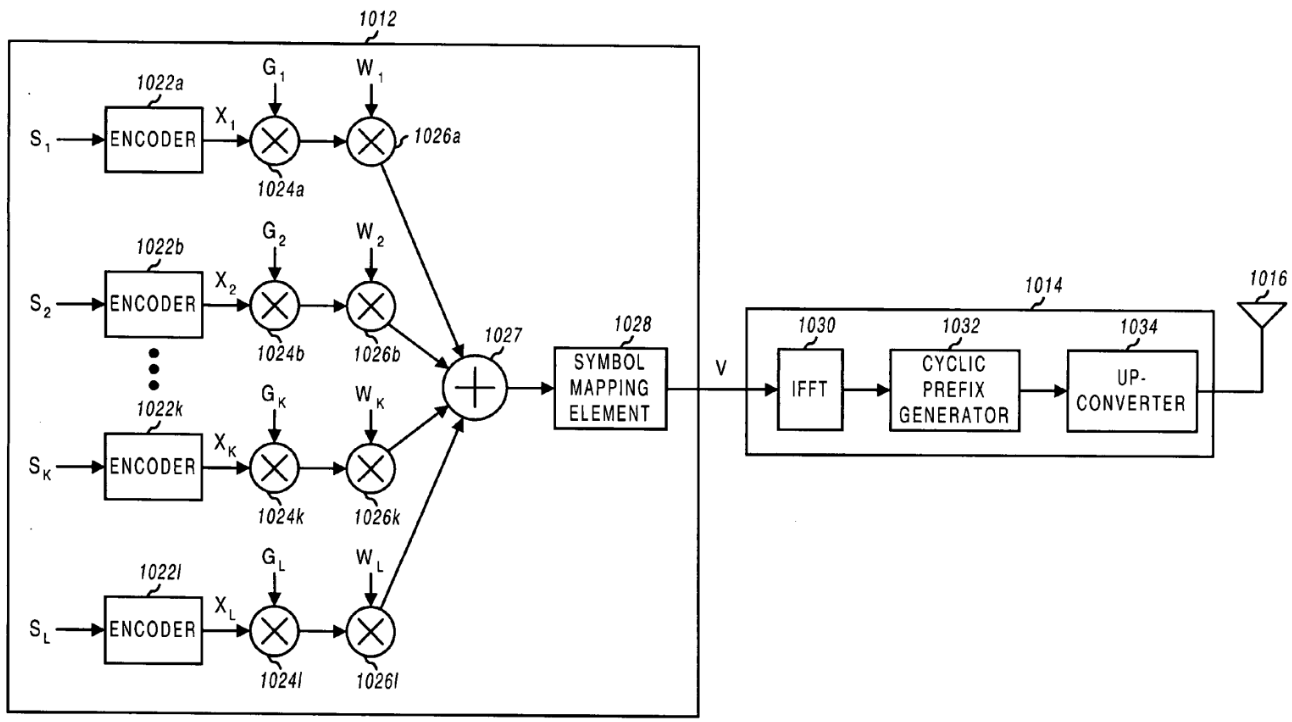
<table>
<tr><th>Claim 14 of the ’802 Patent</th><th>Prior Art Reference – Jalali</th></tr>
<tr><td></td><td>


FIG. 10

See, e.g., Jalali at Figure 10.

The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility.

See, e.g., Jalali at 1:24-28.
</td></tr>
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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps th e data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding sch eme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.3] receiving the transmitted signal on a second antenna;	Jalali discloses "receiving the transmitted signal on a second antenna." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM

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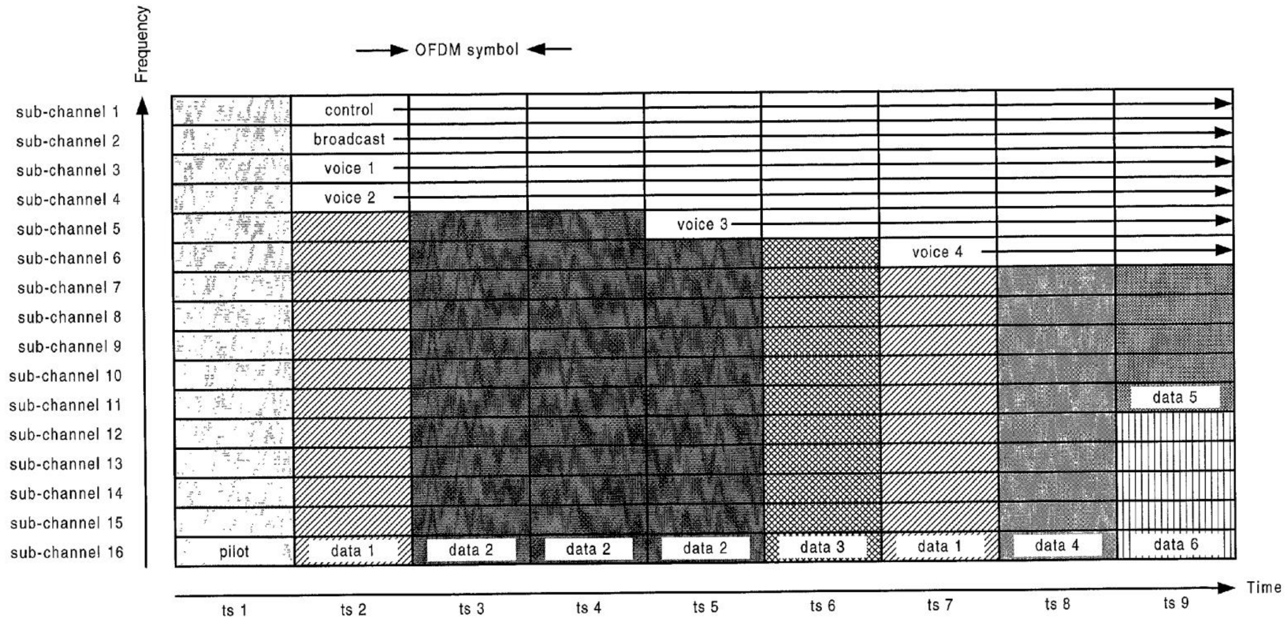
	symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  FIG. 2 *See*, *e.g.*, Jalali at Figure 2.

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	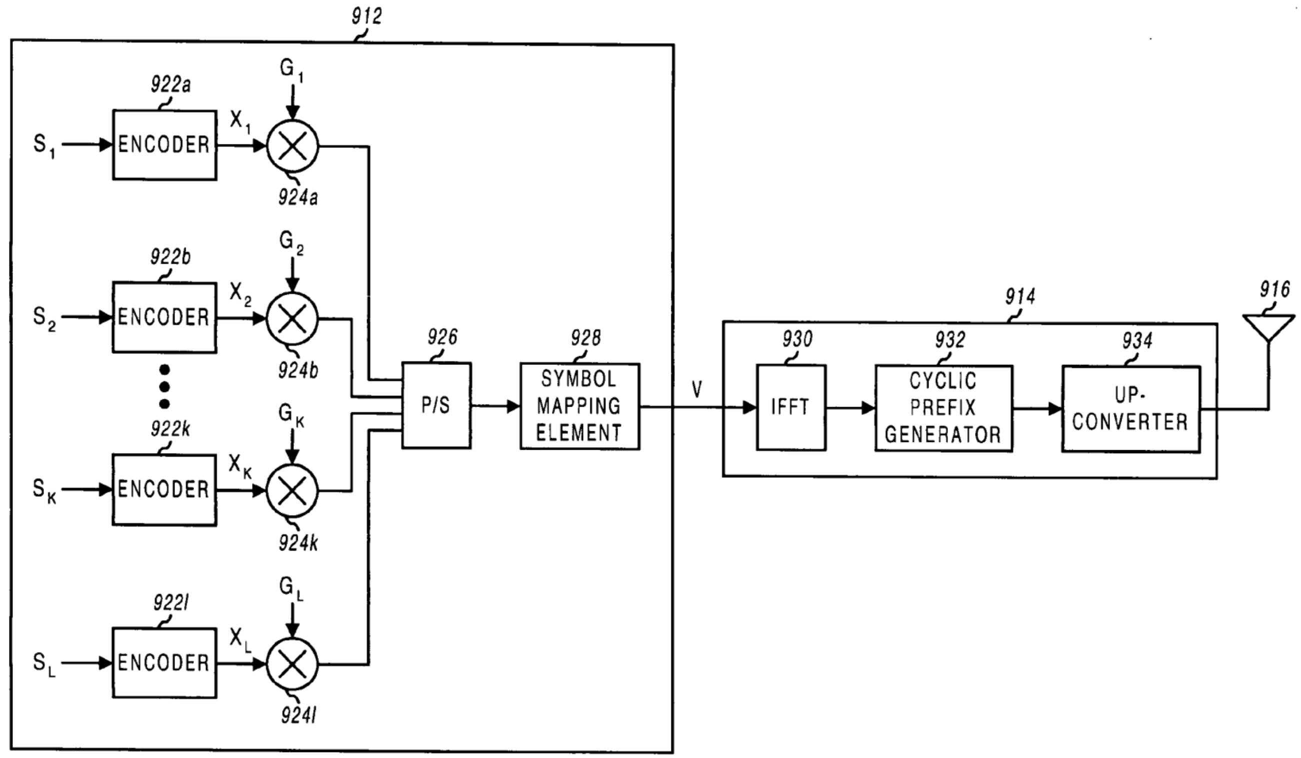 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

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	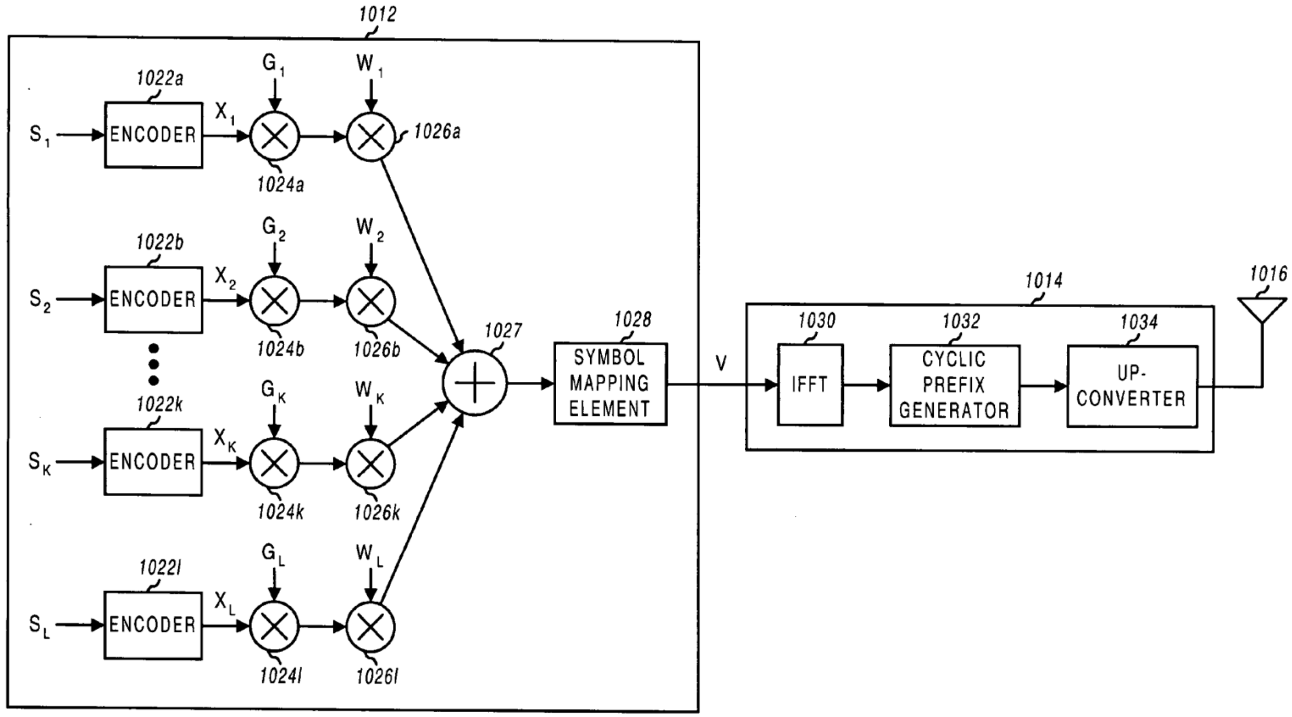 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See*, *e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See*, *e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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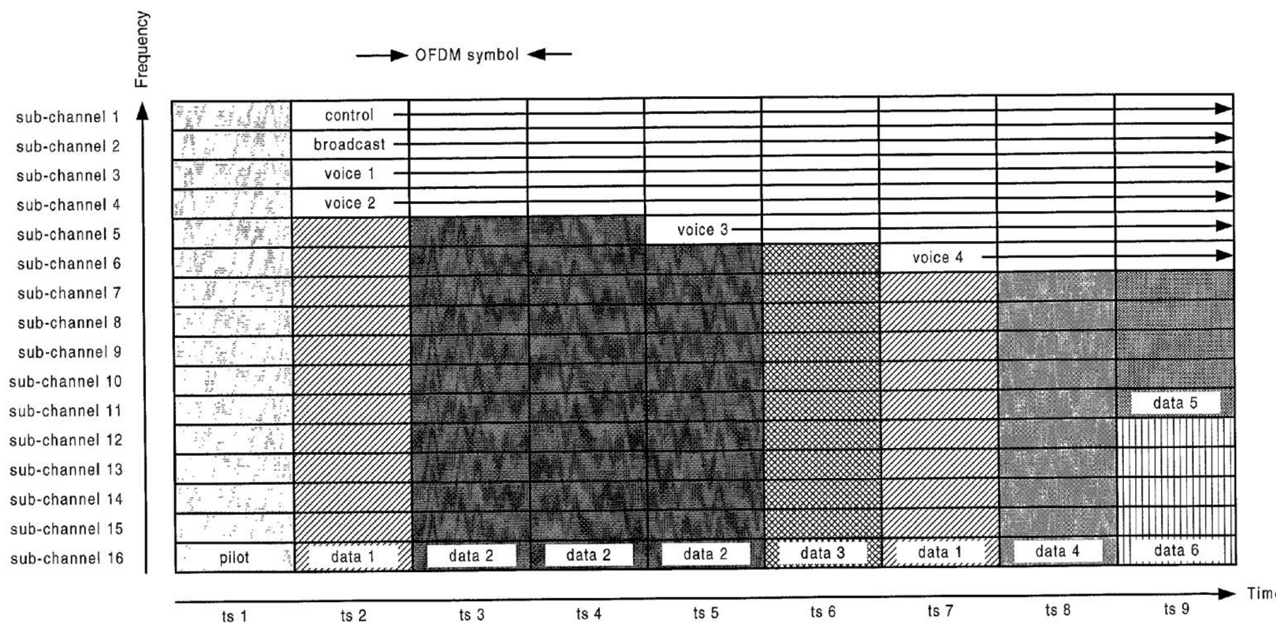
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 14 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.4] amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal, wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the first up-converted frequency range and the highest frequency in the second up-converted frequency range;	Jalali discloses “amplifying the received signal in a low noise amplifier resulting in an amplified received up-converted signal, wherein the bandwidth of said low noise amplifier is greater than the difference between the lowest frequency in the first up-converted frequency range and the highest frequency in the second up-converted frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  *FIG. 2* *See*, *e.g.*, Jalali at Figure 2.

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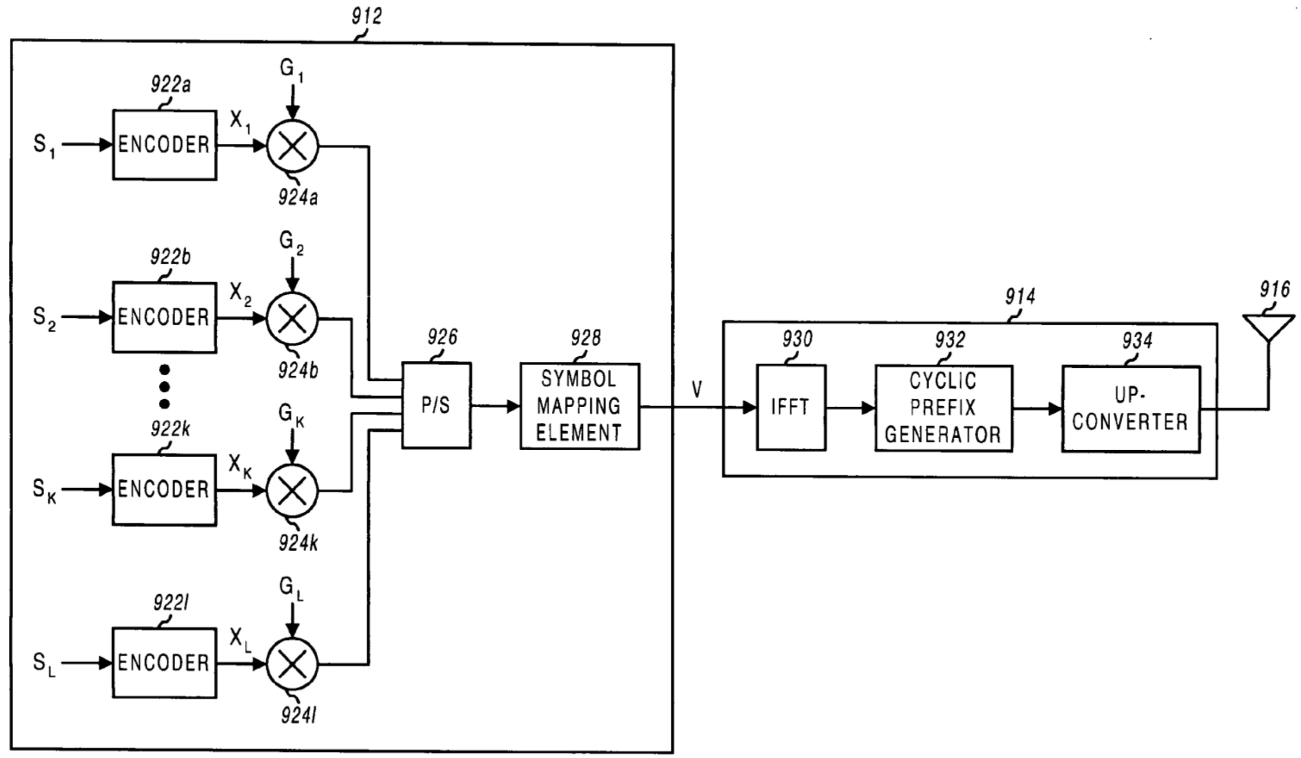
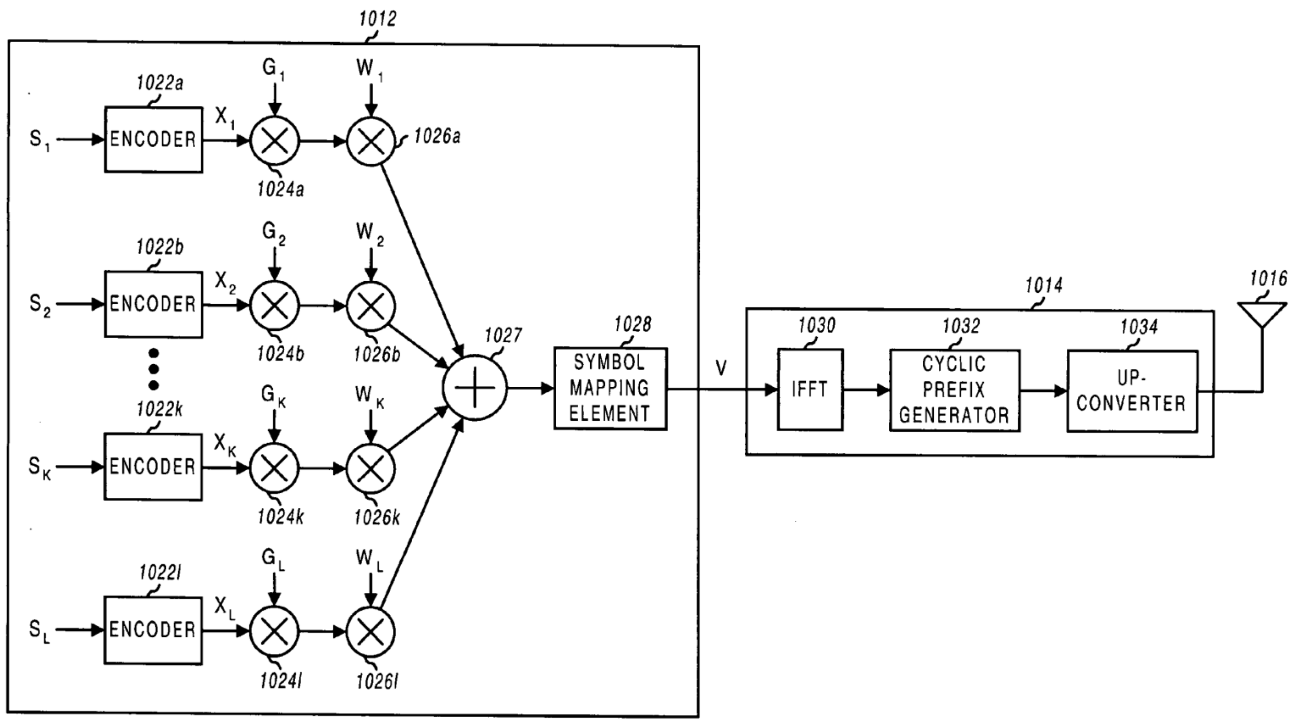
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 14 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See*, *e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.5] down-converting the amplified received up-converted signal using a first down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal corresponding to the first analog signal; and	Jalali discloses "down-converting the amplified received up-converted signal using a first down-converter and a signal corresponding to the first RF center frequency to produce a fourth analog signal corresponding to the first analog signal." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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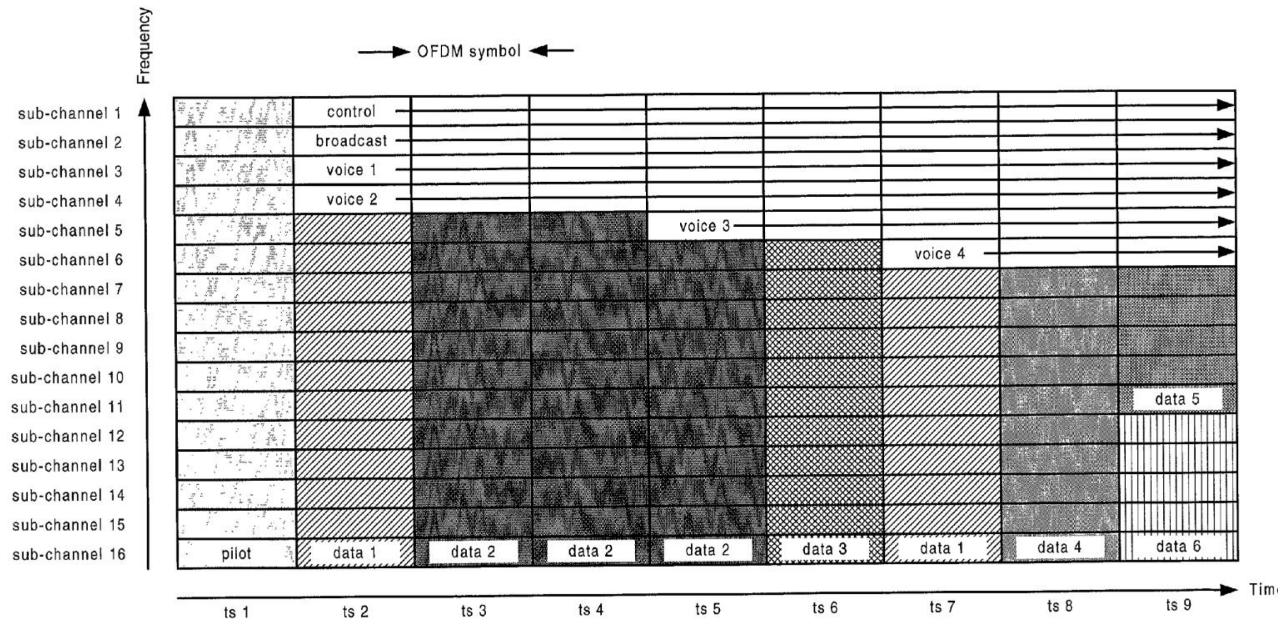
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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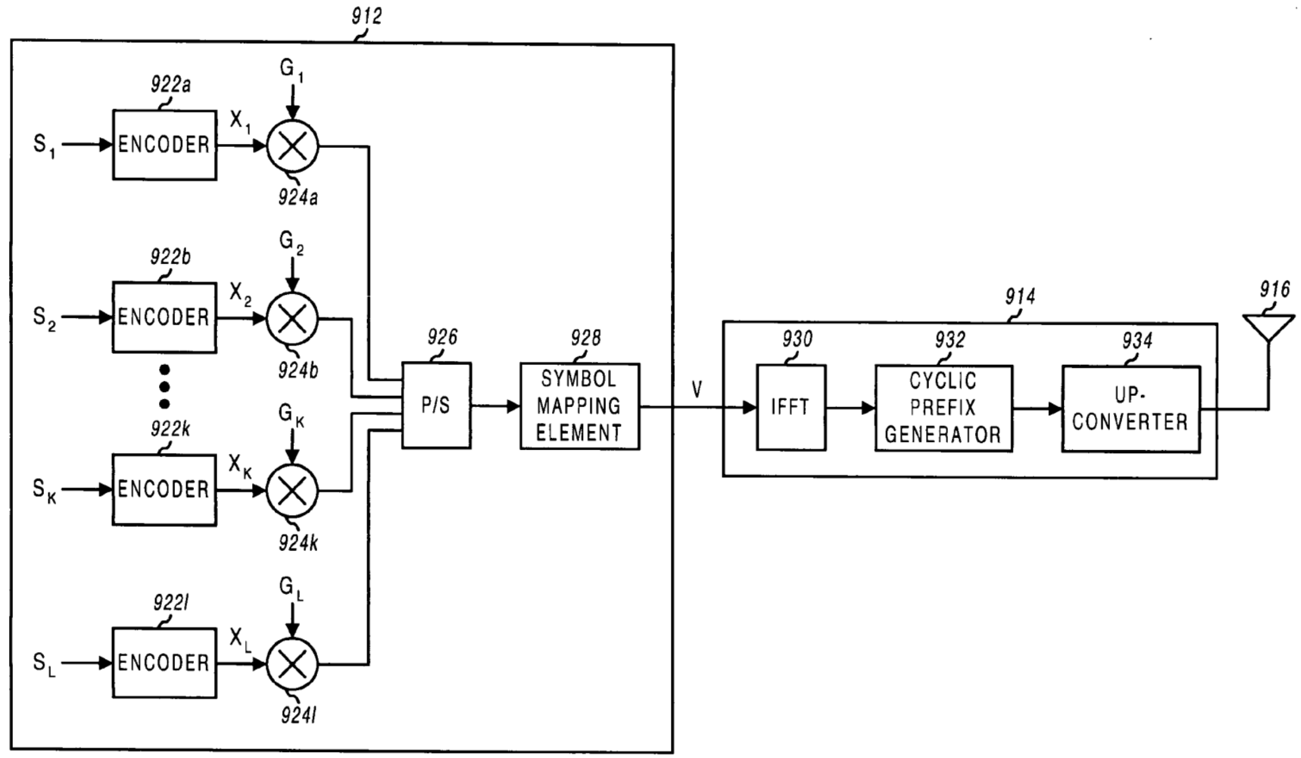
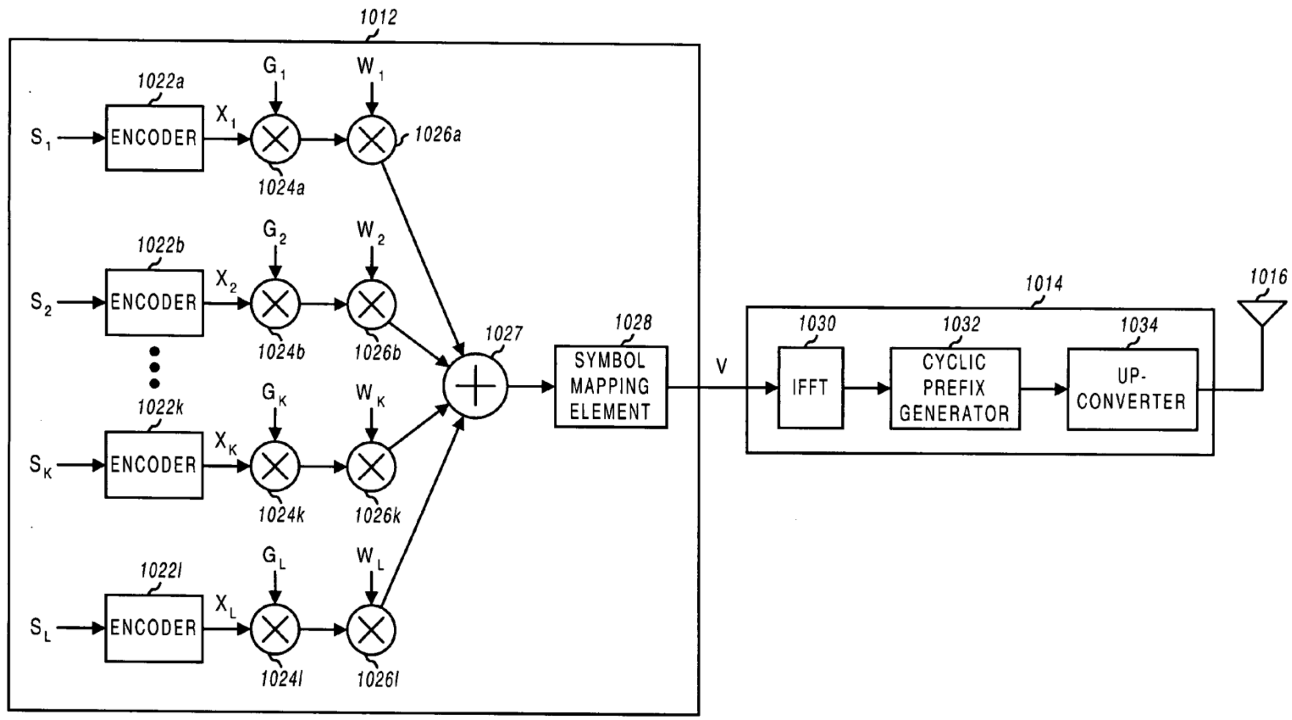
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

<table>
<tr><th>Claim 14 of the ’802 Patent</th><th>Prior Art Reference – Jalali</th></tr>
<tr><td></td><td>
FIG. 10

See, e.g., Jalali at Figure 10.

The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility.

See, e.g., Jalali at 1:24-28.</td></tr>
</table>

Claim 14 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 14 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 14 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[14.6] down-converting the amplified received up-converted analog signal using a second down-converter and a signal corresponding to the second RF center frequency to produce a fifth analog signal corresponding to the second analog signal.	Jalali discloses “down-converting the amplified received up-converted analog signal using a second down-converter and a signal corresponding to the second RF center frequency to produce a fifth analog signal corresponding to the second analog signal.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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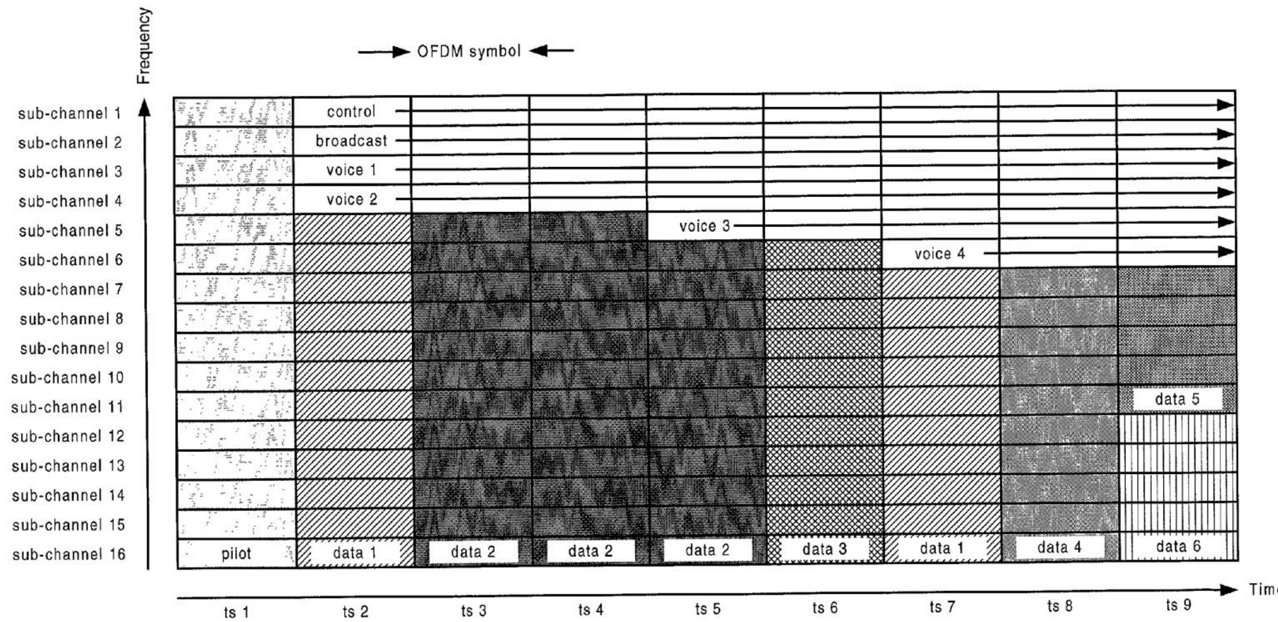
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	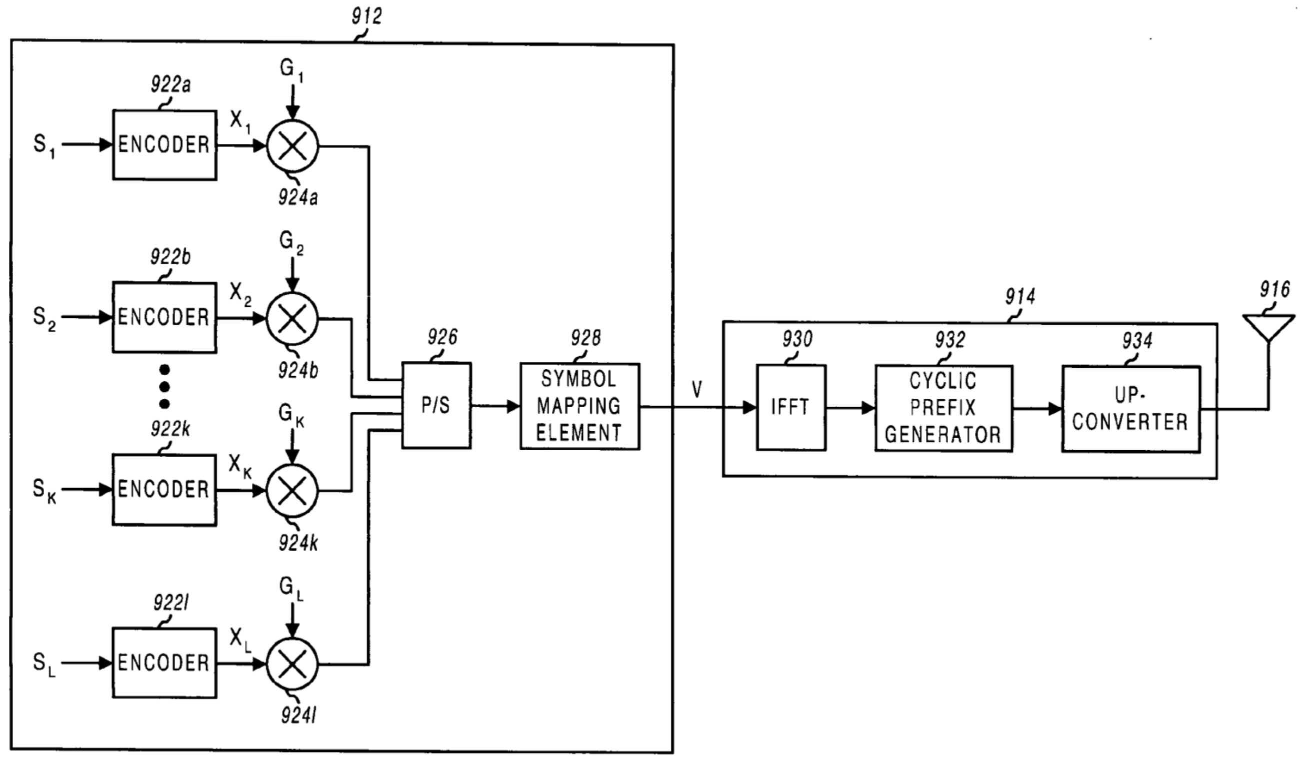 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

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	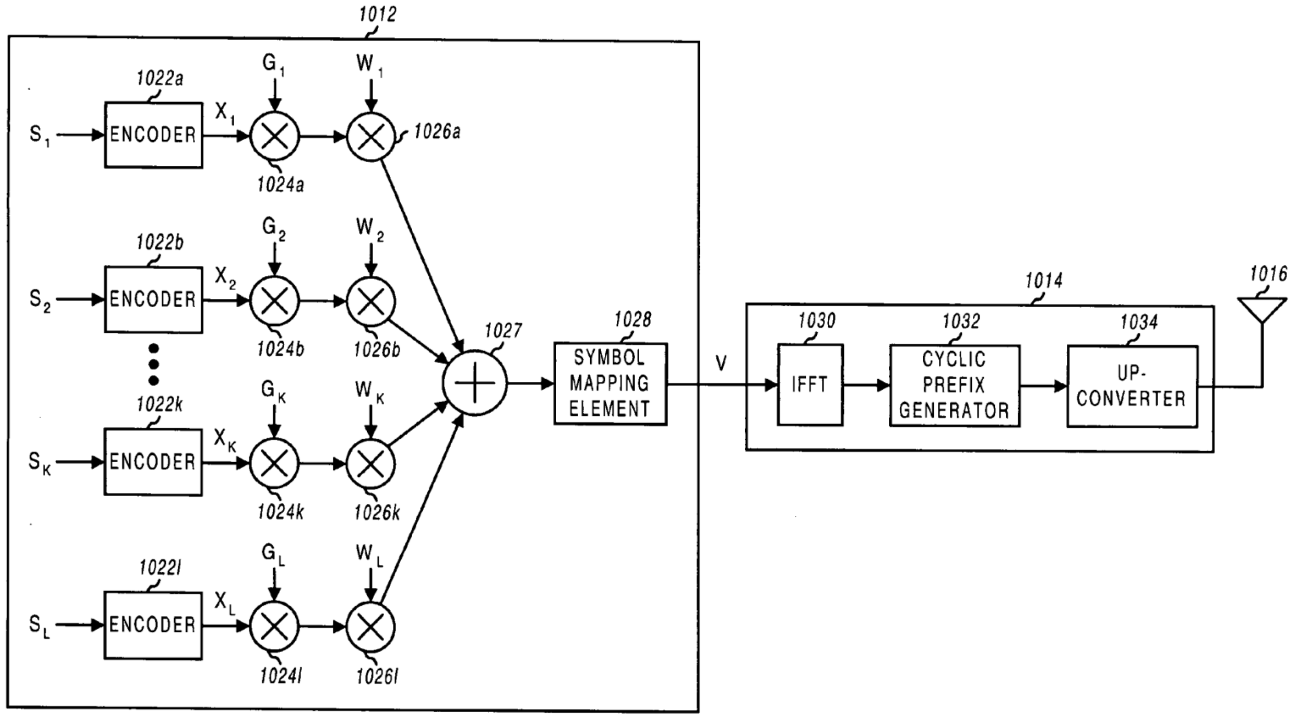 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See, e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

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[17.1] A wireless communication system comprising:	To the extent the preamble is limiting, Jalali discloses “A wireless communication system comprising.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

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	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.2] a baseband digital system for providing a first digital signal comprising a first data to be transmitted and a second digital signal comprising a second data to be transmitted;	Jalali discloses "a baseband digital system for providing a first digital signal comprising a first data to be transmitted and a second digital signal comprising a second data to be transmitted." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM

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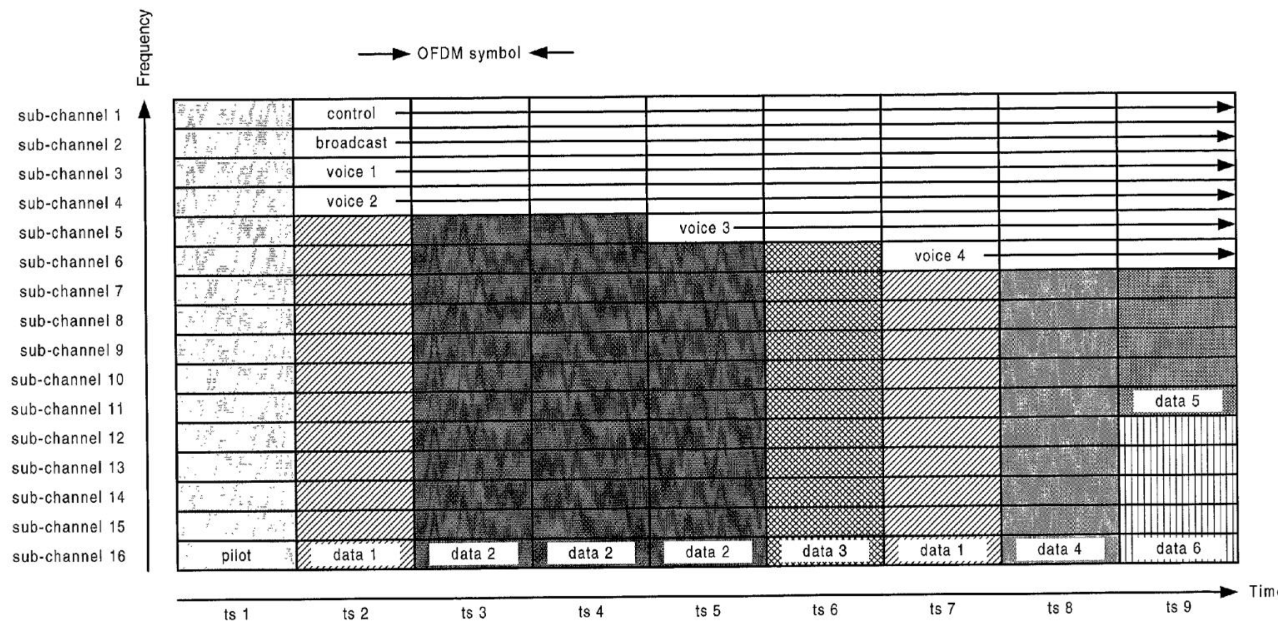
	symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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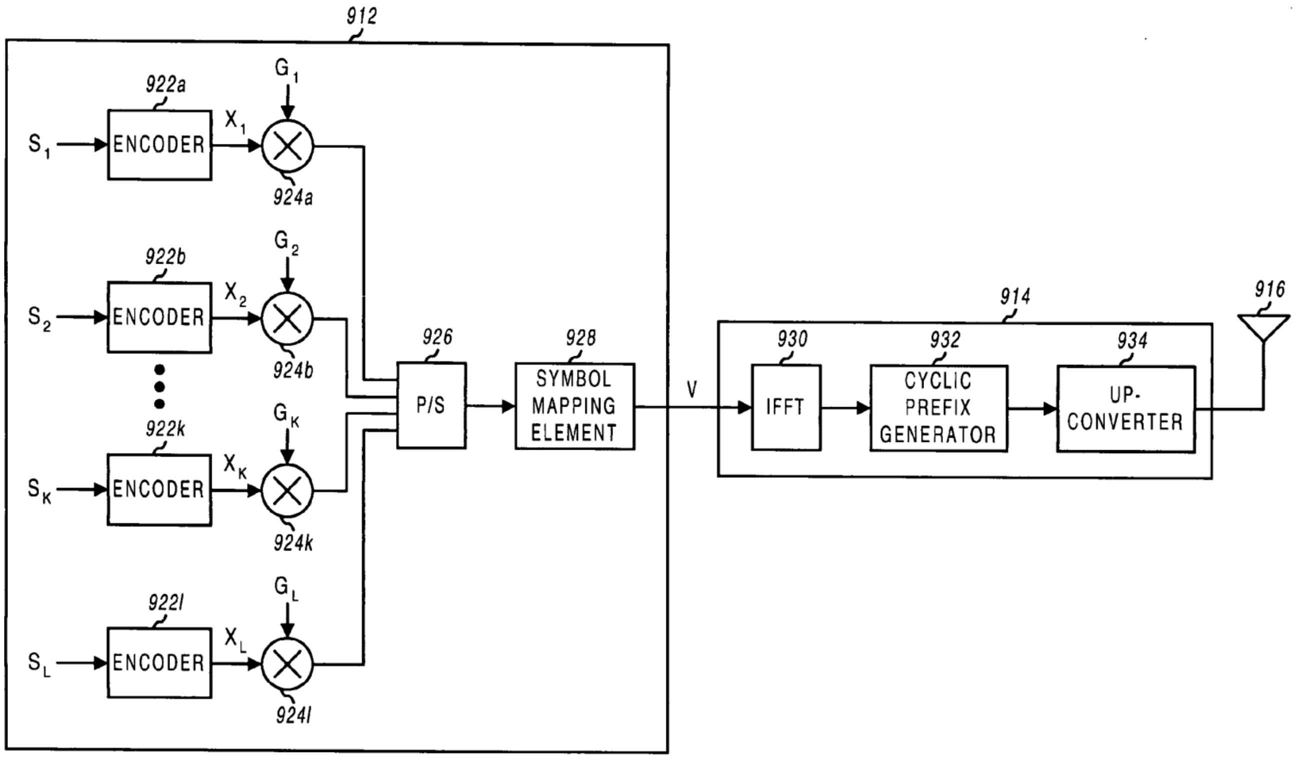
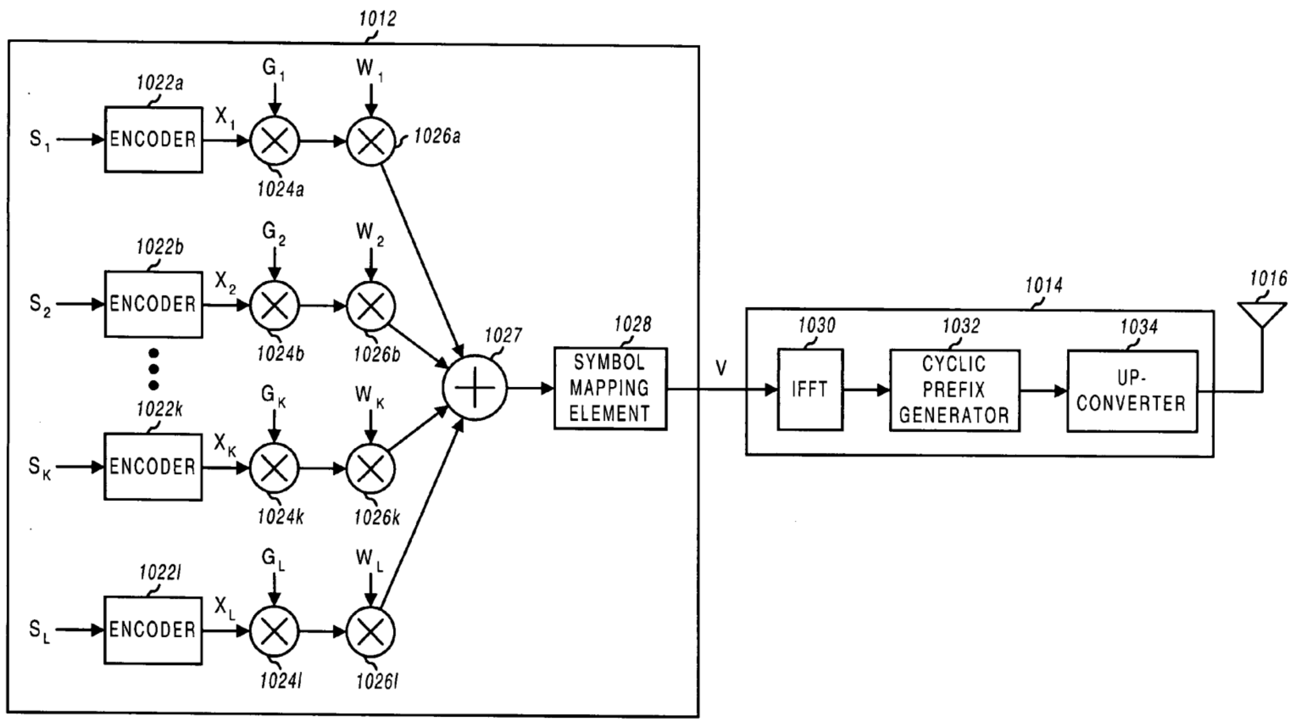
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.3] a first digital-to-analog converter for receiving the first digital signal and converting the first digital signal into a first analog signal, the first analog signal carrying the first data across a first frequency range;	Jalali discloses "a first digital-to-analog converter for receiving the first digital signal and converting the first digital signal into a first analog signal, the first analog signal carrying the first data across a first frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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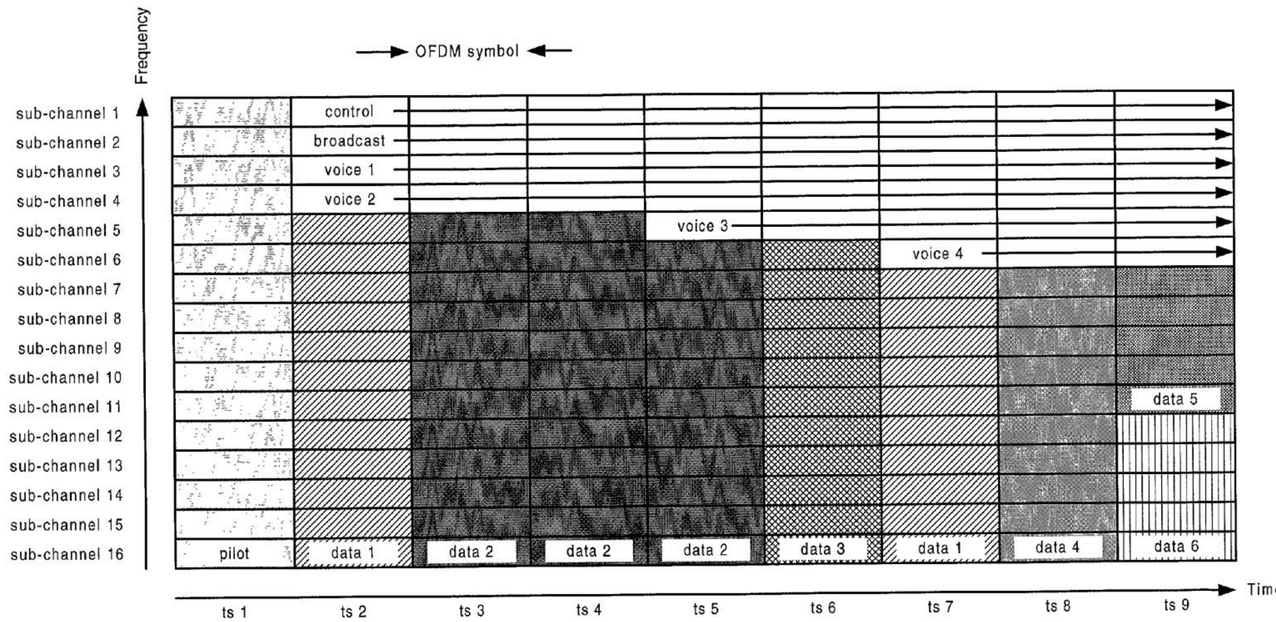
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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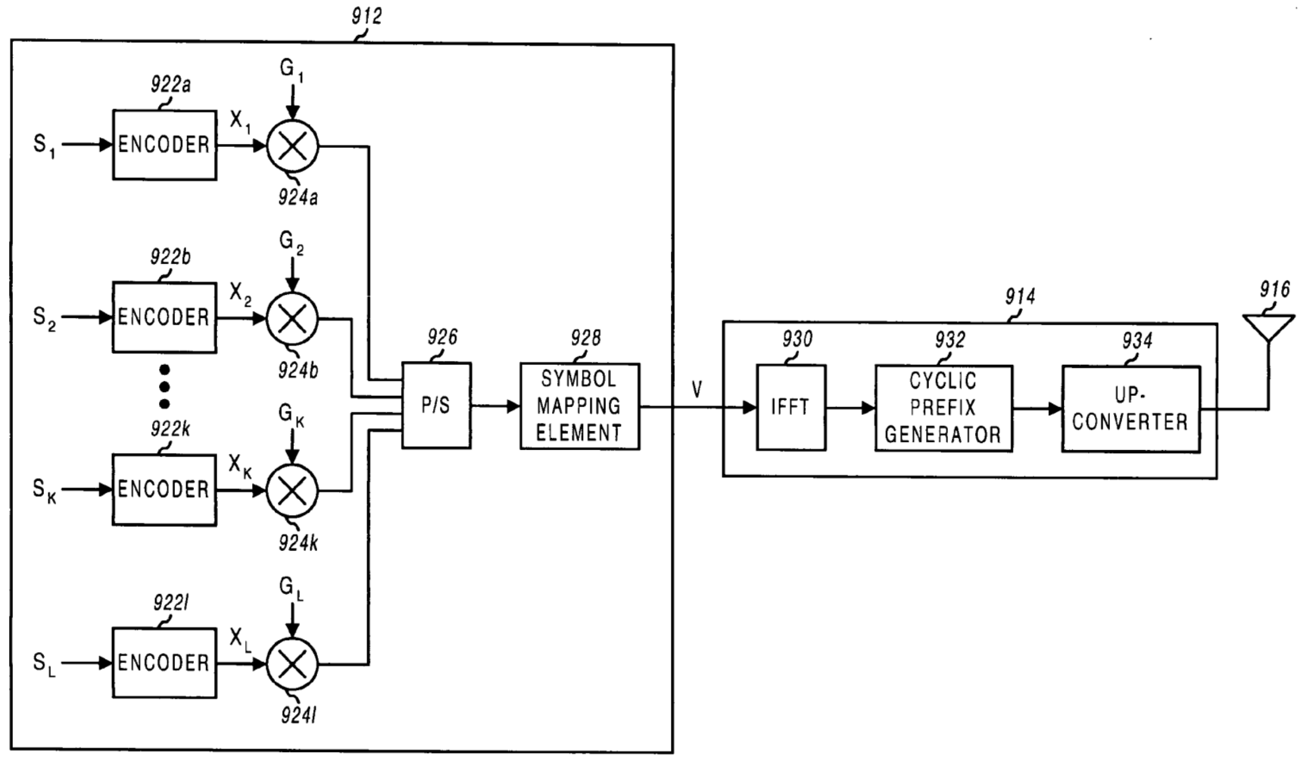
<tr><td></td><td>

FIG. 9

See, e.g., Jalali at Figure 9.</td></tr>
</table>

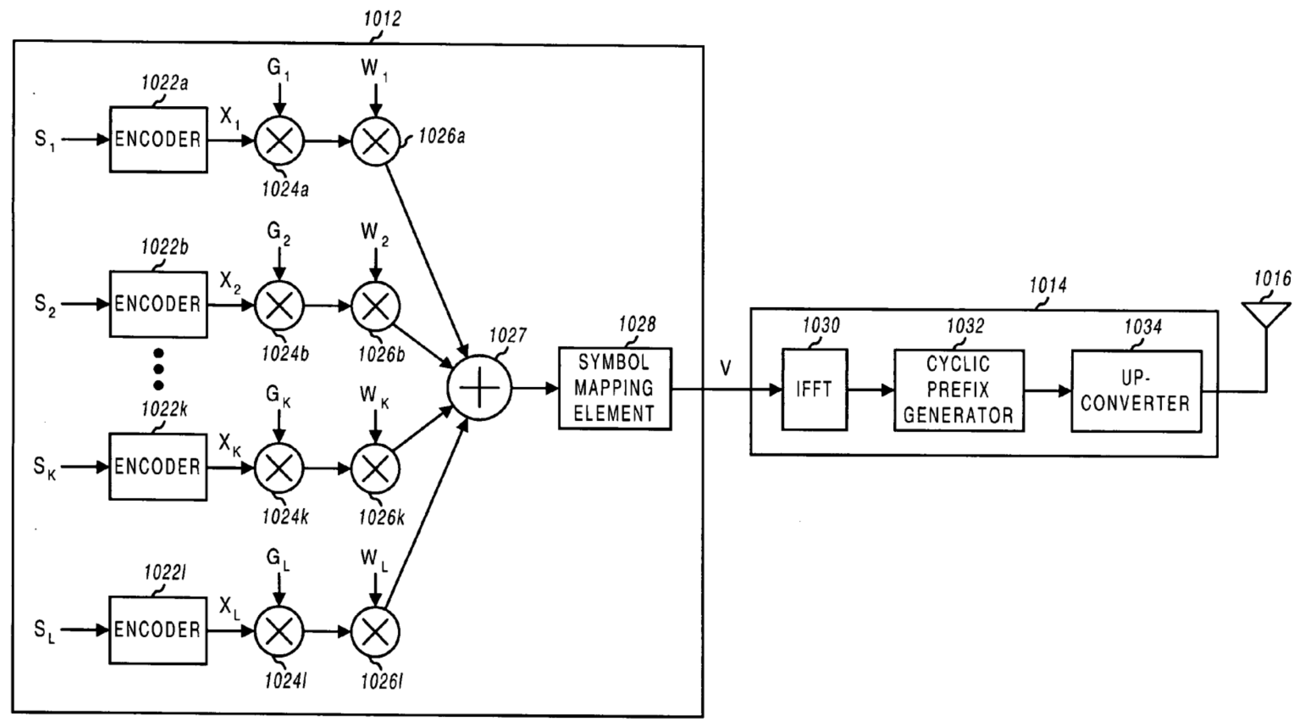
<table>
<tr><th>Claim 17 of the ’802 Patent</th><th>Prior Art Reference – Jalali</th></tr>
<tr><td></td><td>

FIG. 10

See, e.g., Jalali at Figure 10.

The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility.

See, e.g., Jalali at 1:24-28.</td></tr>
</table>

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

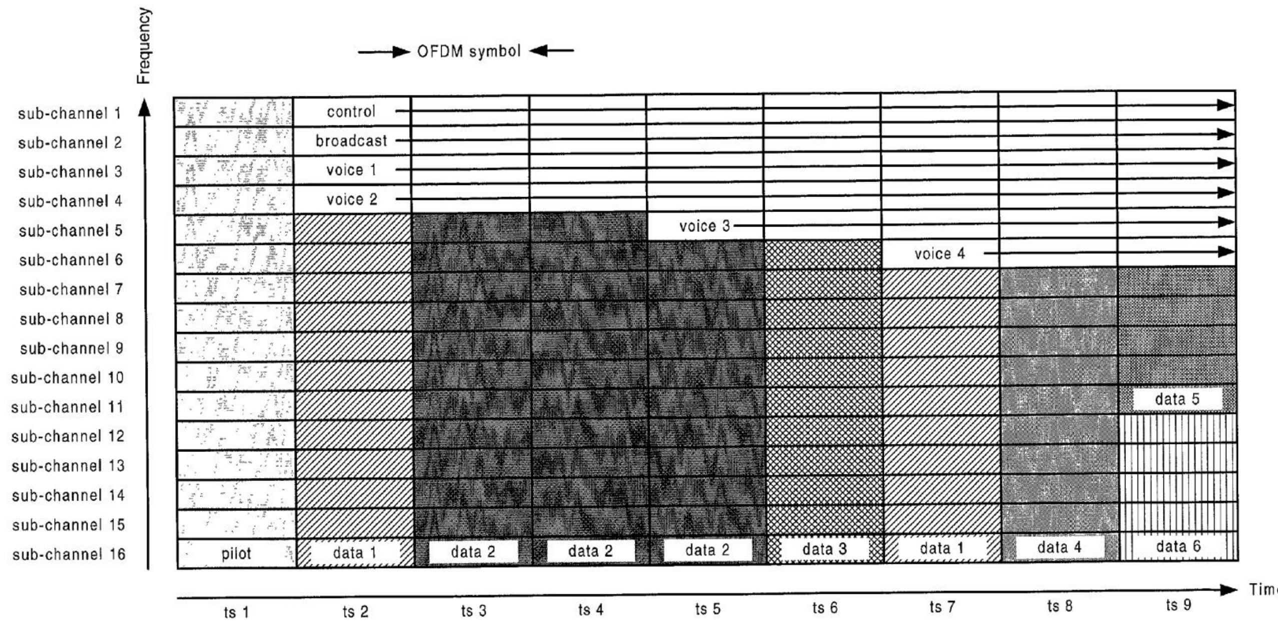
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

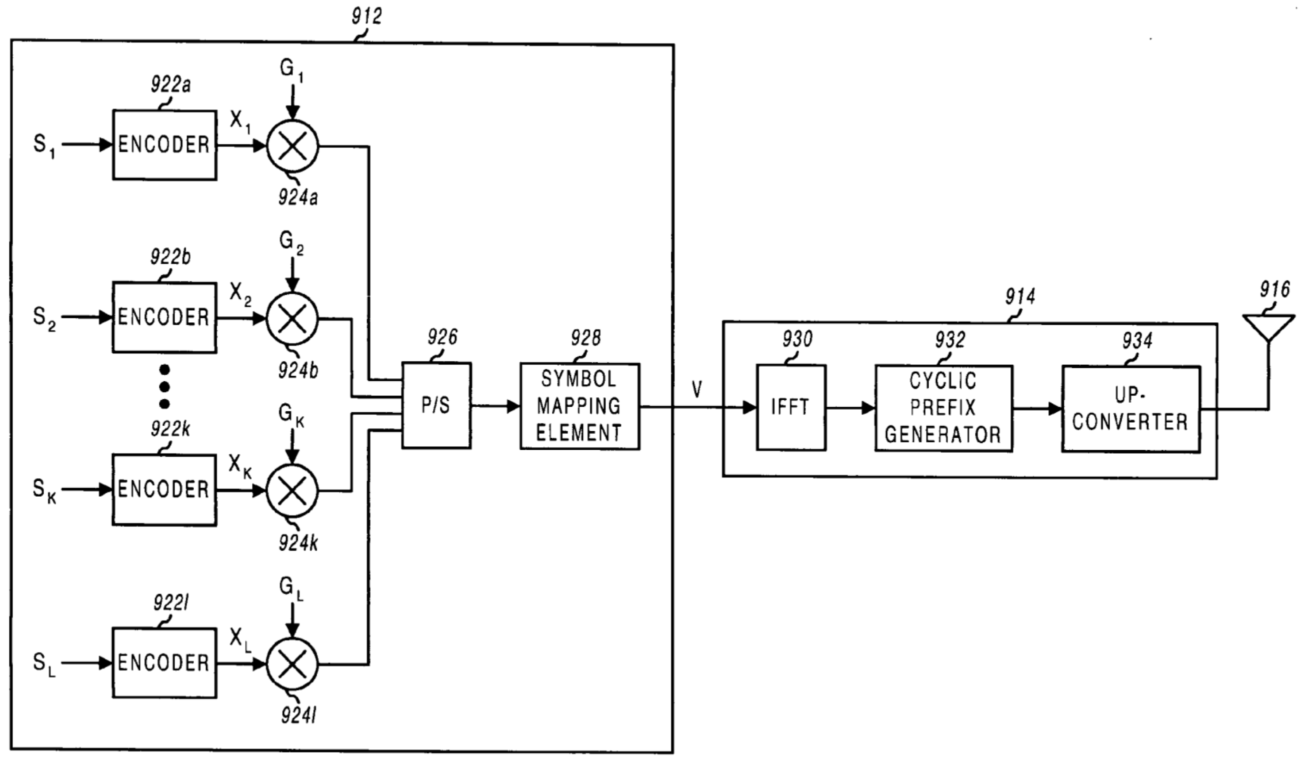
Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

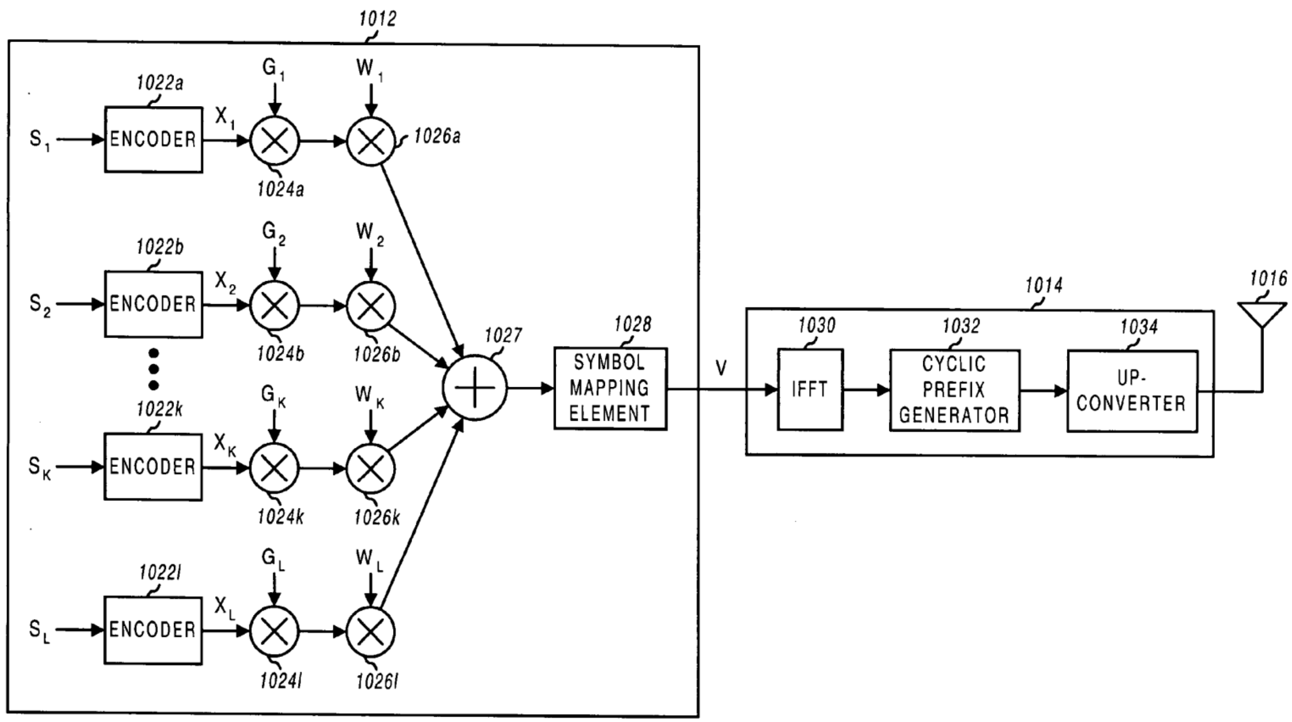
Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.4] a second digital-to-analog converter for receiving the second digital signal and converting the second digital signal into a second analog signal, the second analog signal carrying the second data across a second frequency range;	Jalali discloses "a second digital-to-analog converter for receiving the second digital signal and converting the second digital signal into a second analog signal, the second analog signal carrying the second data across a second frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2 *See, e.g.*, Jalali at Figure 2.

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See, e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.5] a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a first RF frequency, wherein the first up-converter outputs a first up-converted analog signal comprising a first up-converted frequency range from the first RF frequency	Jalali discloses “a first up-converter circuit having a first input coupled to receive the first analog signal and a second input coupled to receive a first modulation signal having a first RF frequency, wherein the first up-converter outputs a first up-converted analog signal comprising a first up-converted frequency range from the first RF frequency minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.

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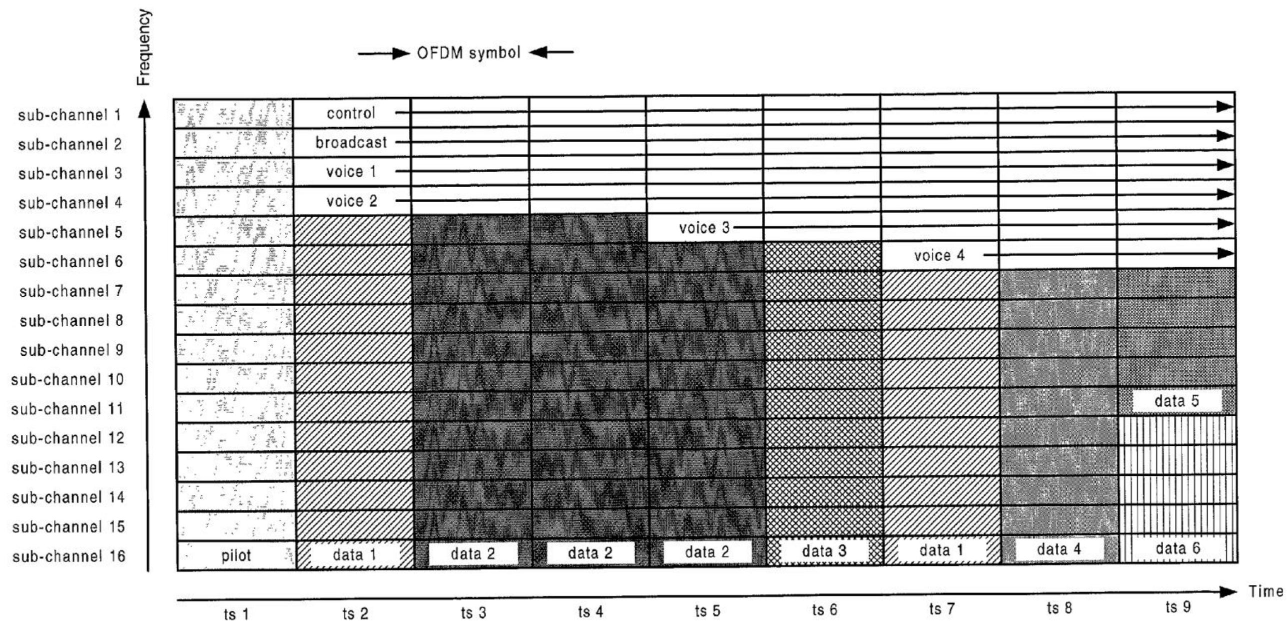
minus one-half the first frequency range to the first RF frequency plus one-half the first frequency range;	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	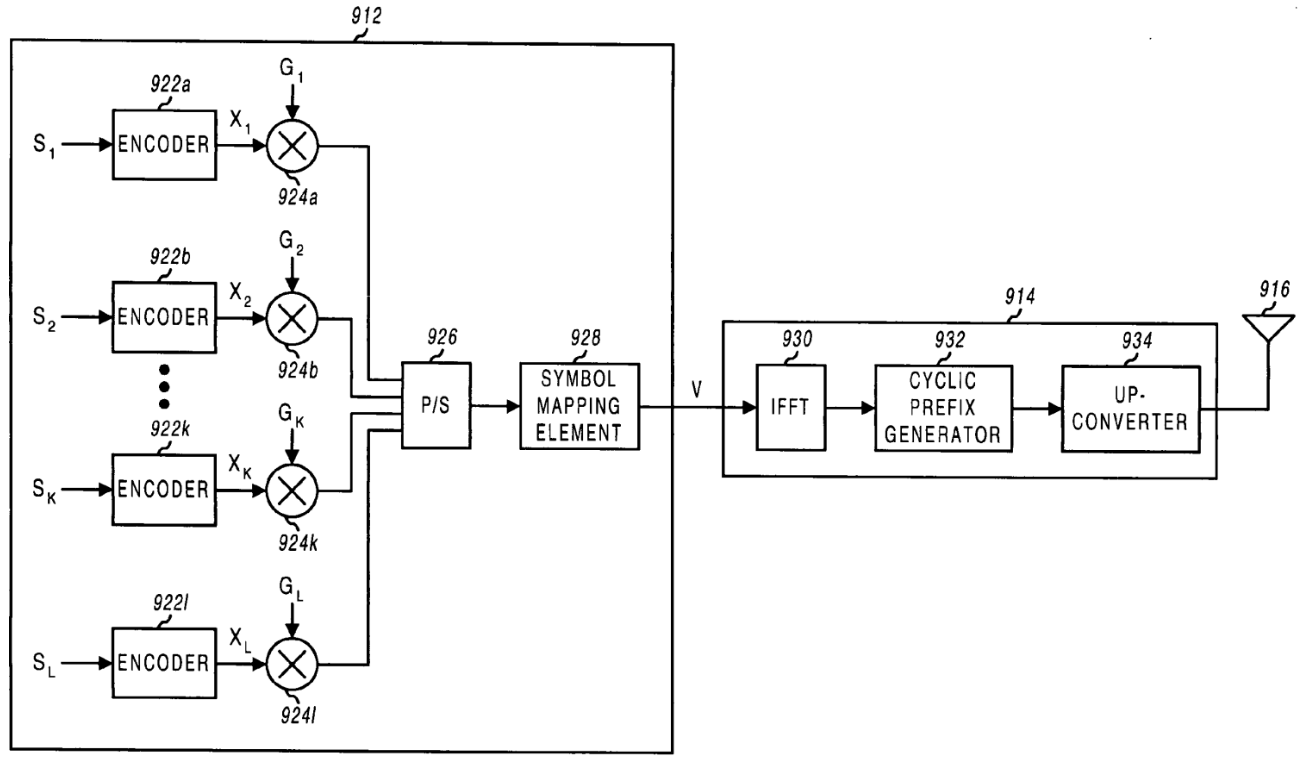 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

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	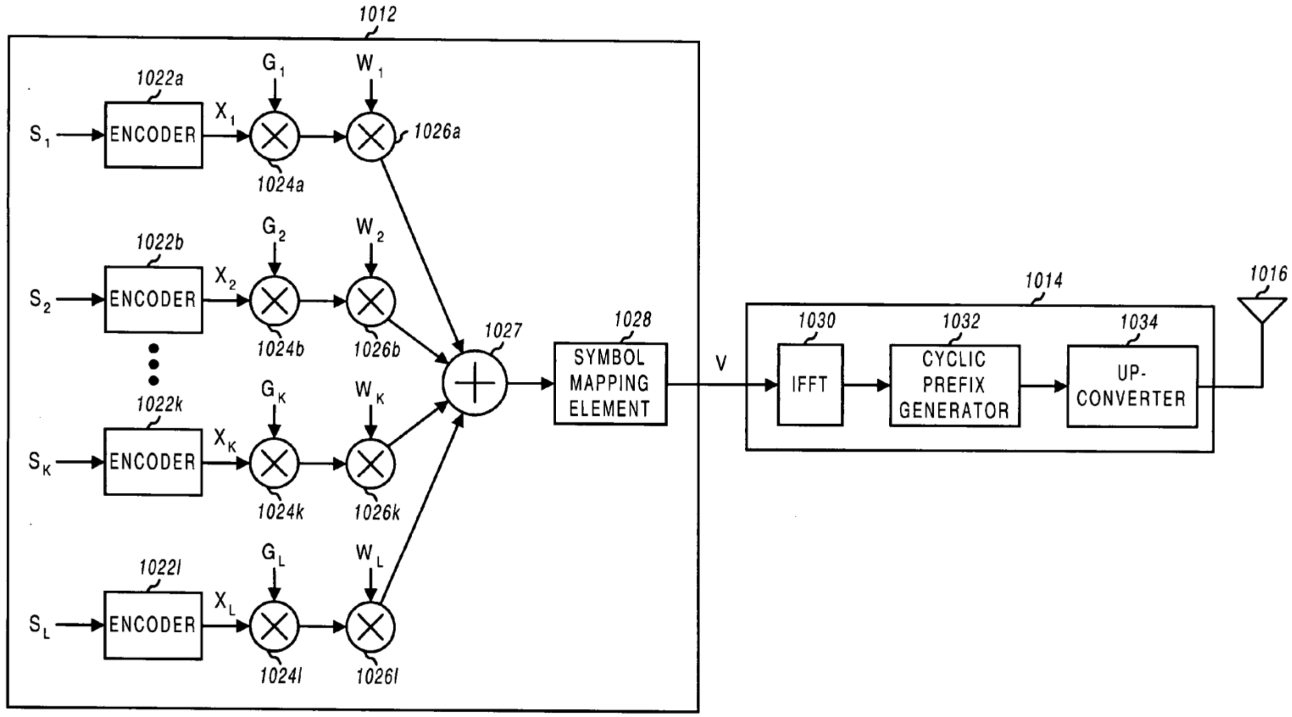 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See*, *e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.6] a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF frequency, wherein the second up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range	Jalali discloses "a second up-converter circuit having a first input coupled to receive the second analog signal and a second input coupled to receive a second modulation signal having a second RF frequency, wherein the second up-converter outputs a second up-converted analog signal comprising a second up-converted frequency range from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data

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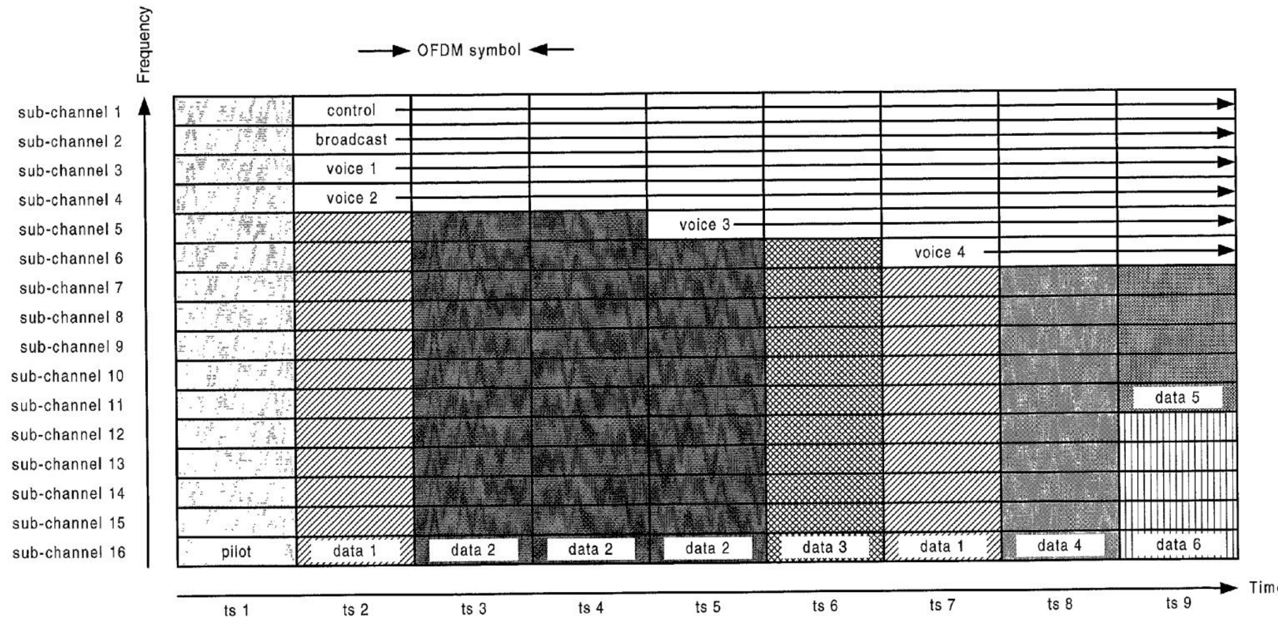
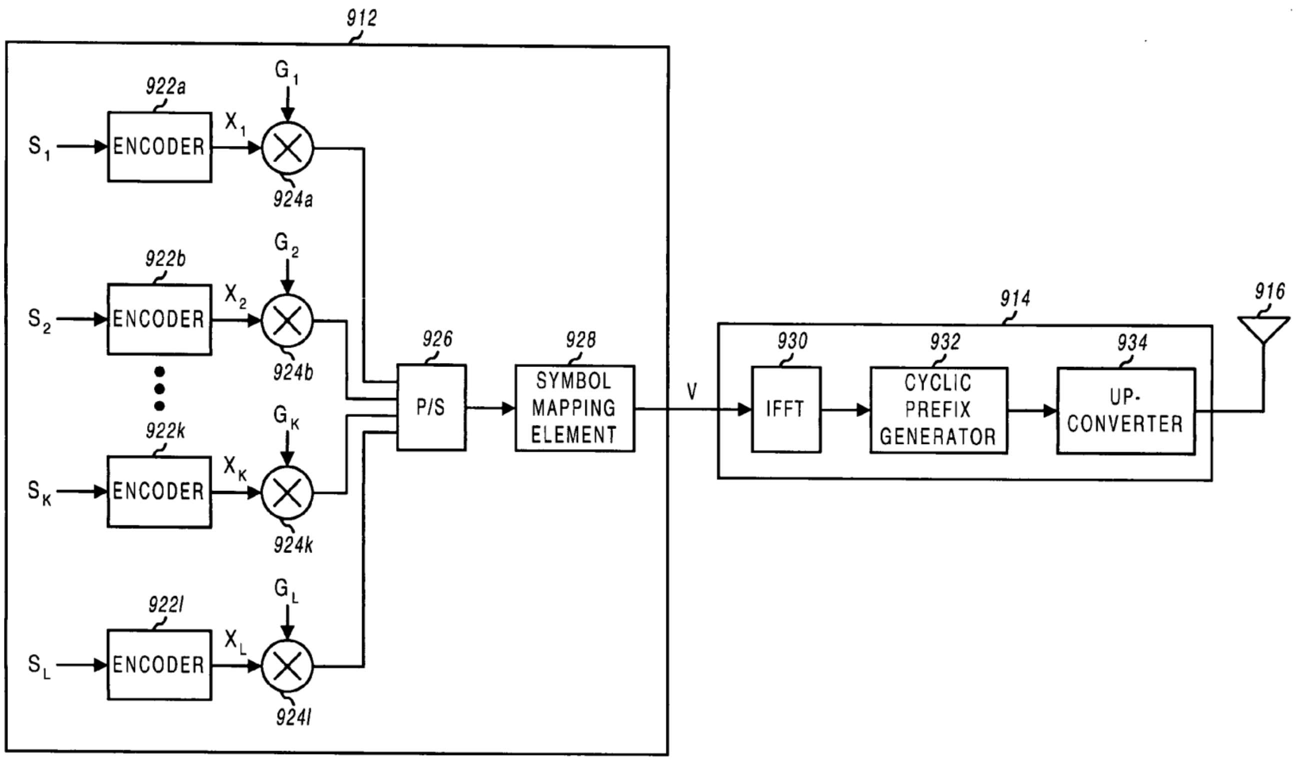
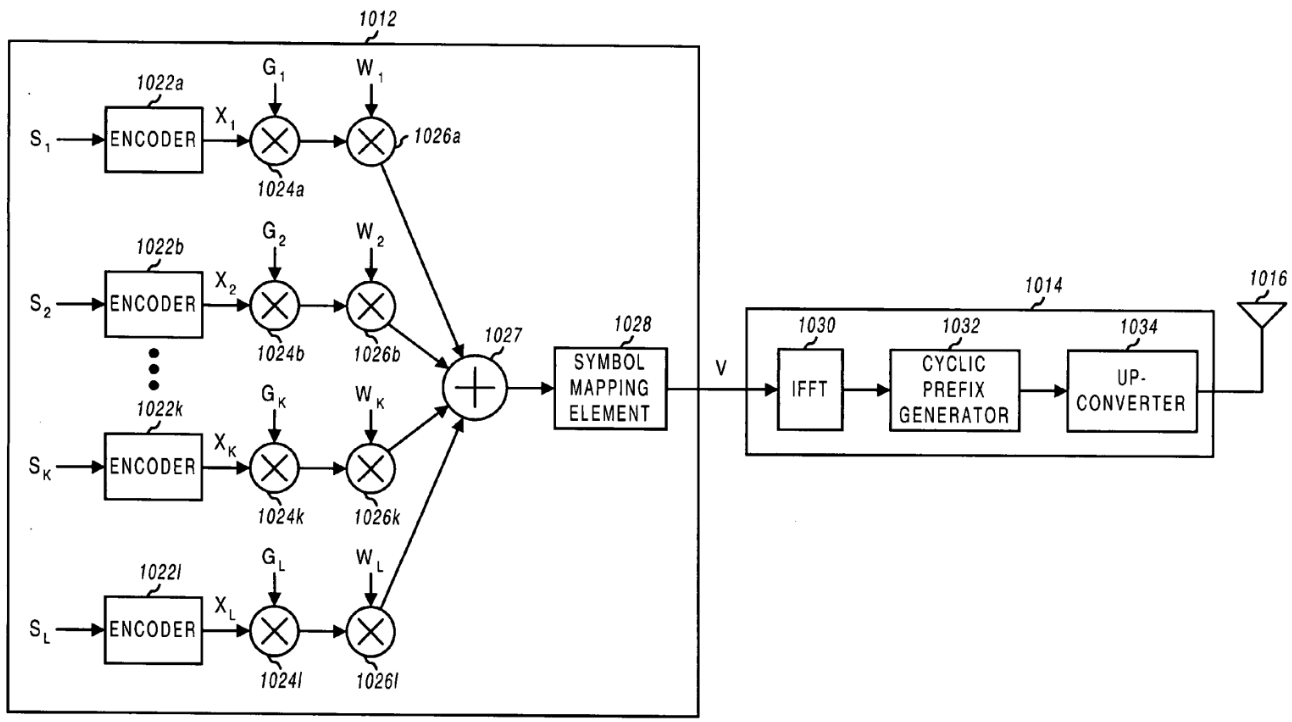
from the second RF frequency minus one-half the second frequency range to the second RF frequency plus one-half the second frequency range, and wherein frequency difference between the first RF frequency and the second RF frequency is greater than the sum of one-half the first frequency range and one-half the second frequency range; and	from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  **FIG. 2**

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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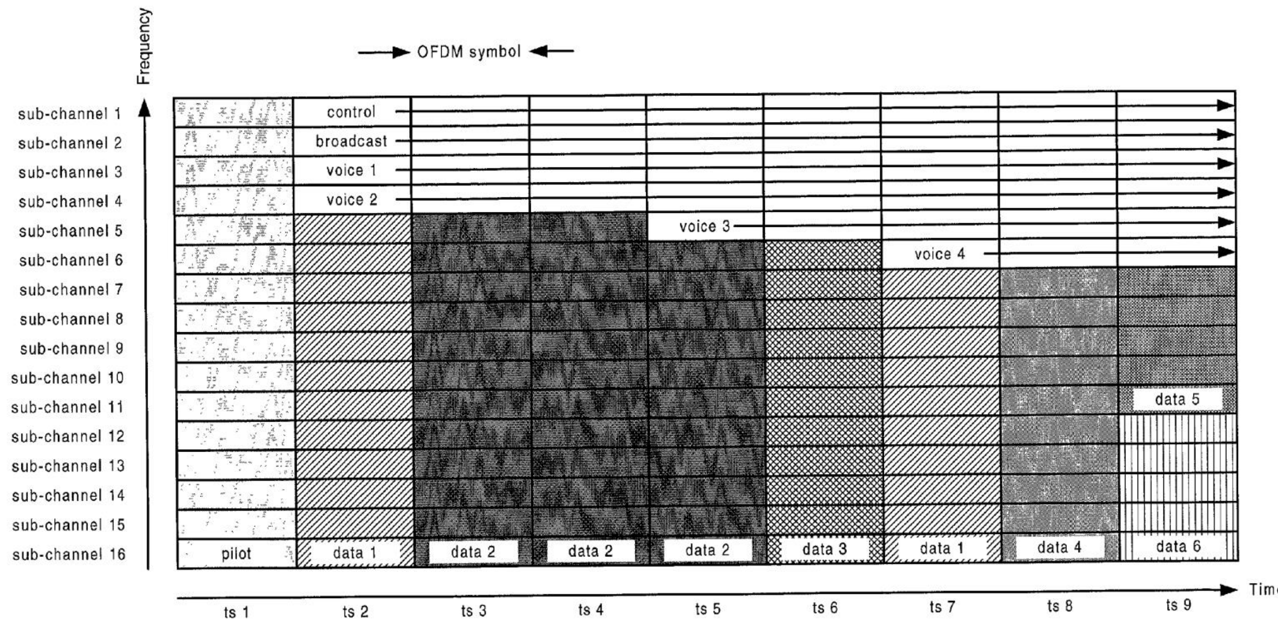
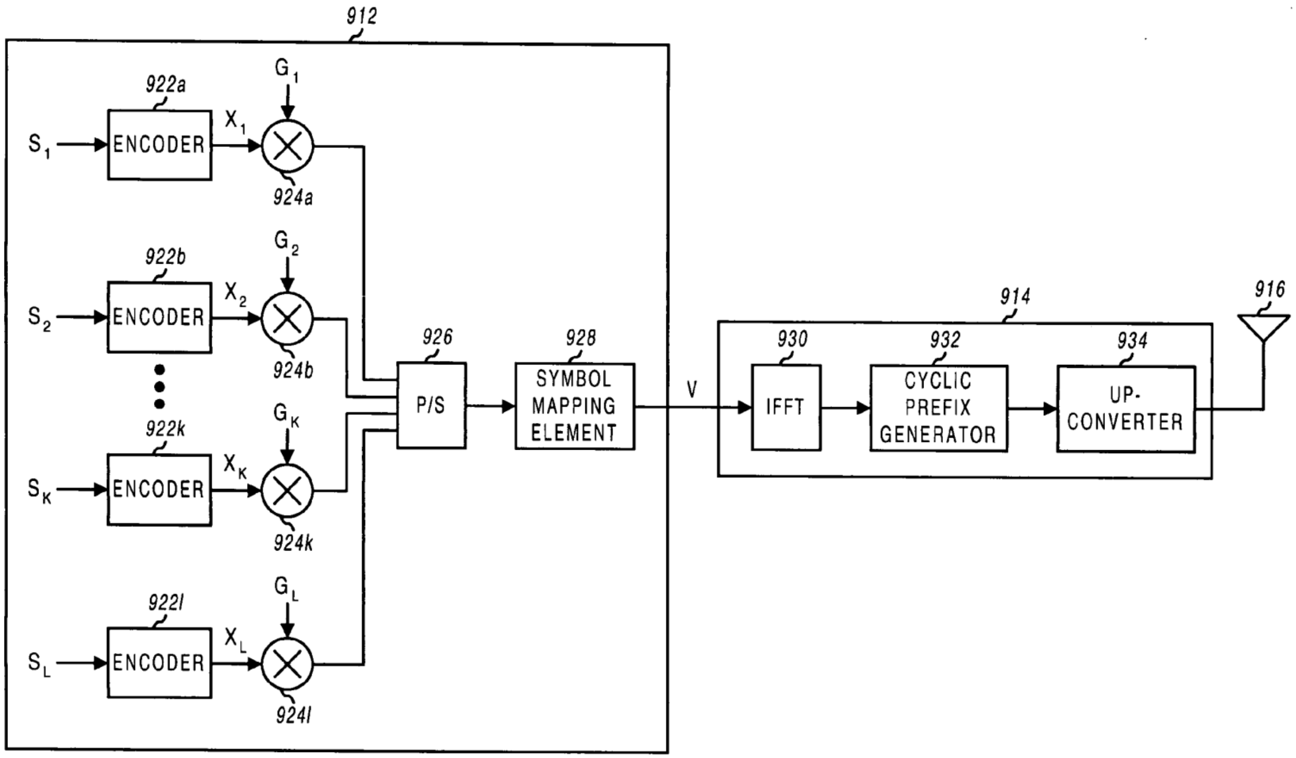
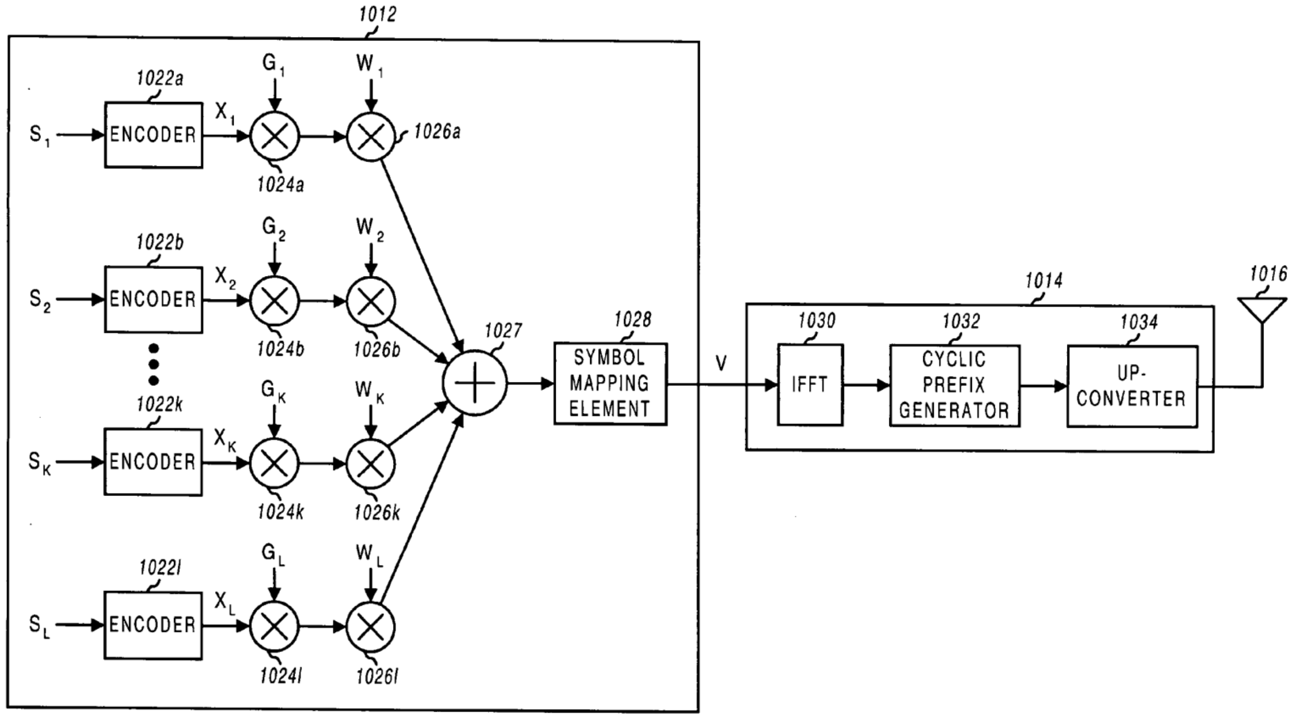
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[17.7] a power amplifier coupled to receive the first and second up-converted analog signals, wherein the bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range.	Jalali discloses “a power amplifier coupled to receive the first and second up-converted analog signals, wherein the bandwidth of the power amplifier is greater than the difference between a lowest frequency in the first up-converted frequency range and a highest frequency in the second up-converted frequency range.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See*, *e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 17 of the ’802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 17 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 21 of the '802 Patent	Prior Art Reference – Jalali
[21.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[21.2] wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of the second digital signal is encoded using a second wireless protocol.	Jalali discloses "wherein the first data of the first digital signal is encoded using a first wireless protocol and the first data of the second digital signal is encoded using a second wireless protocol." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

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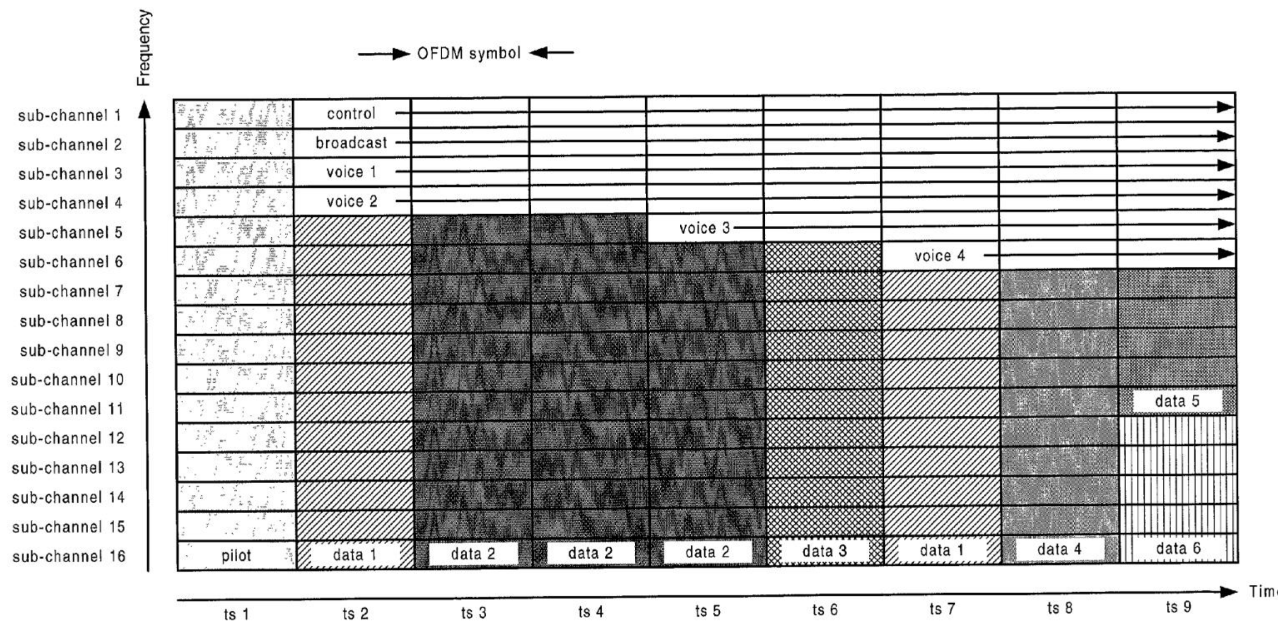
	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.  *FIG. 2*

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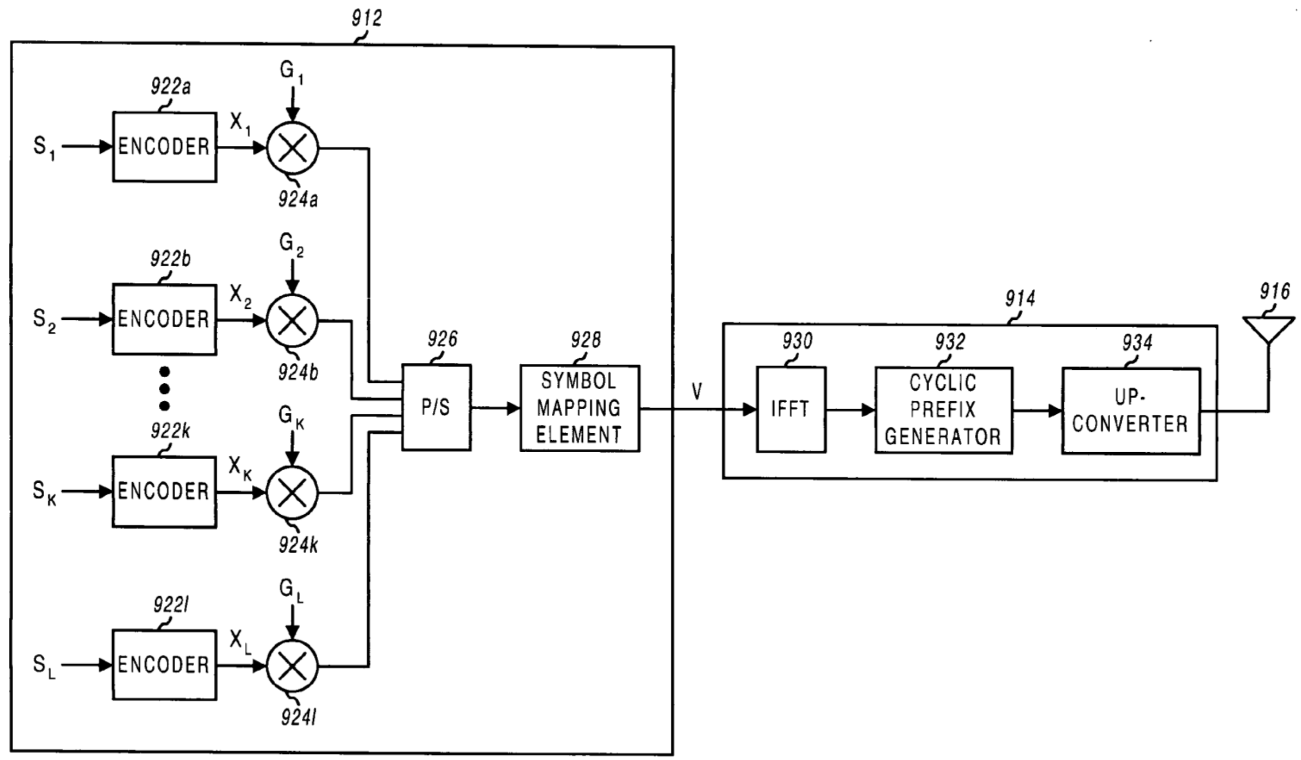
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

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	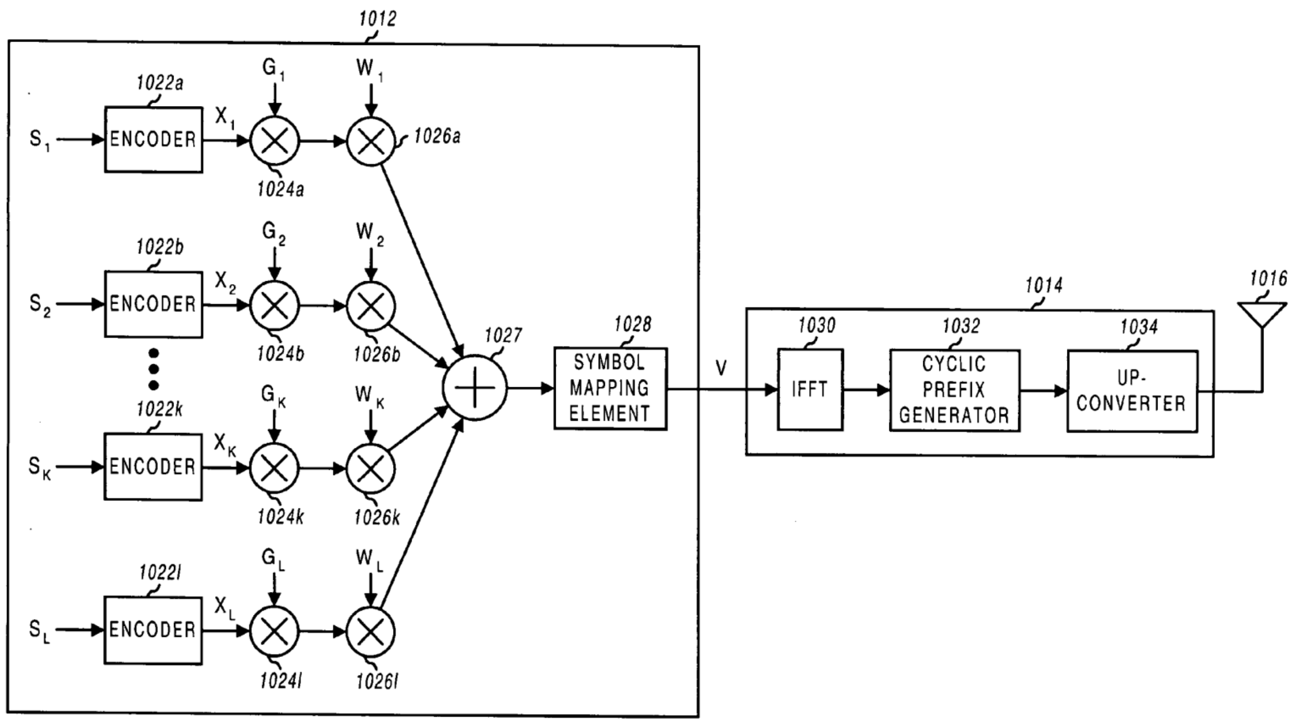 *FIG. 10* *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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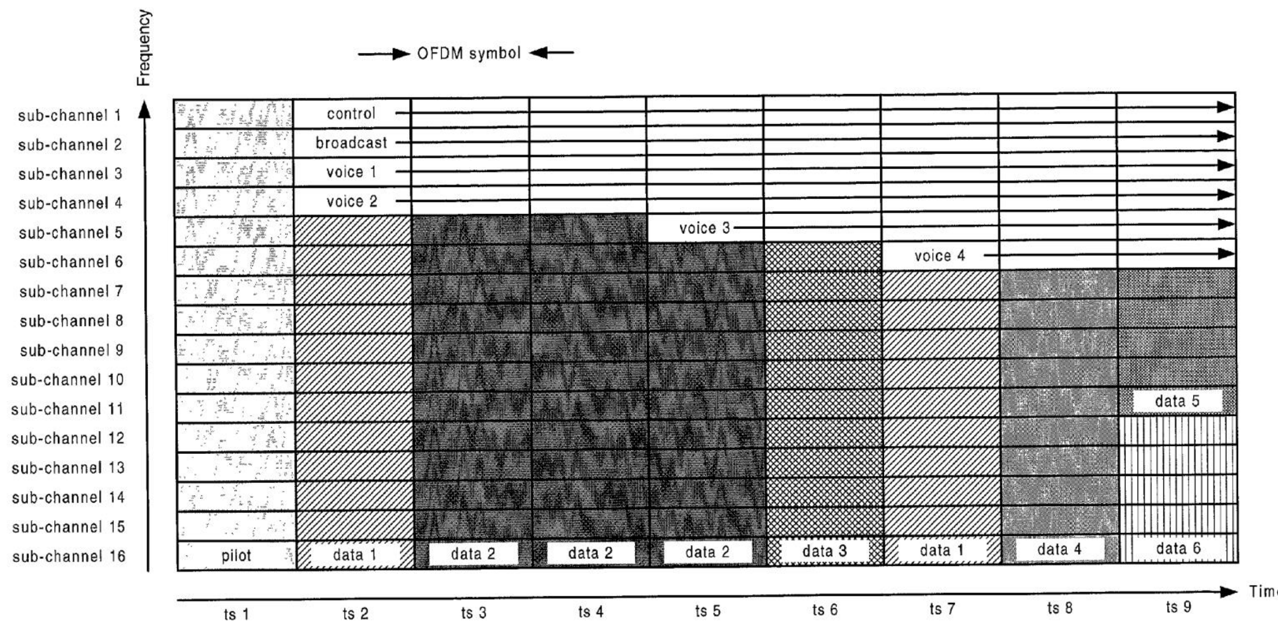
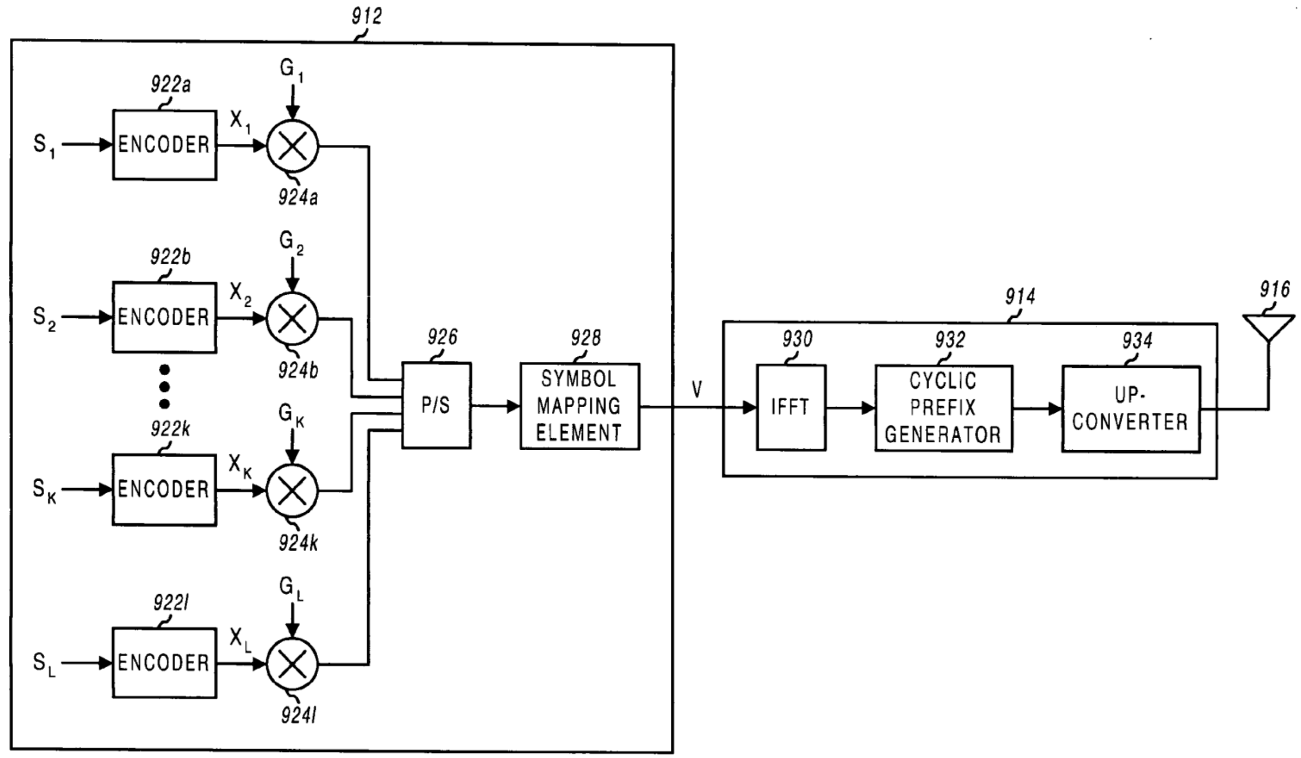
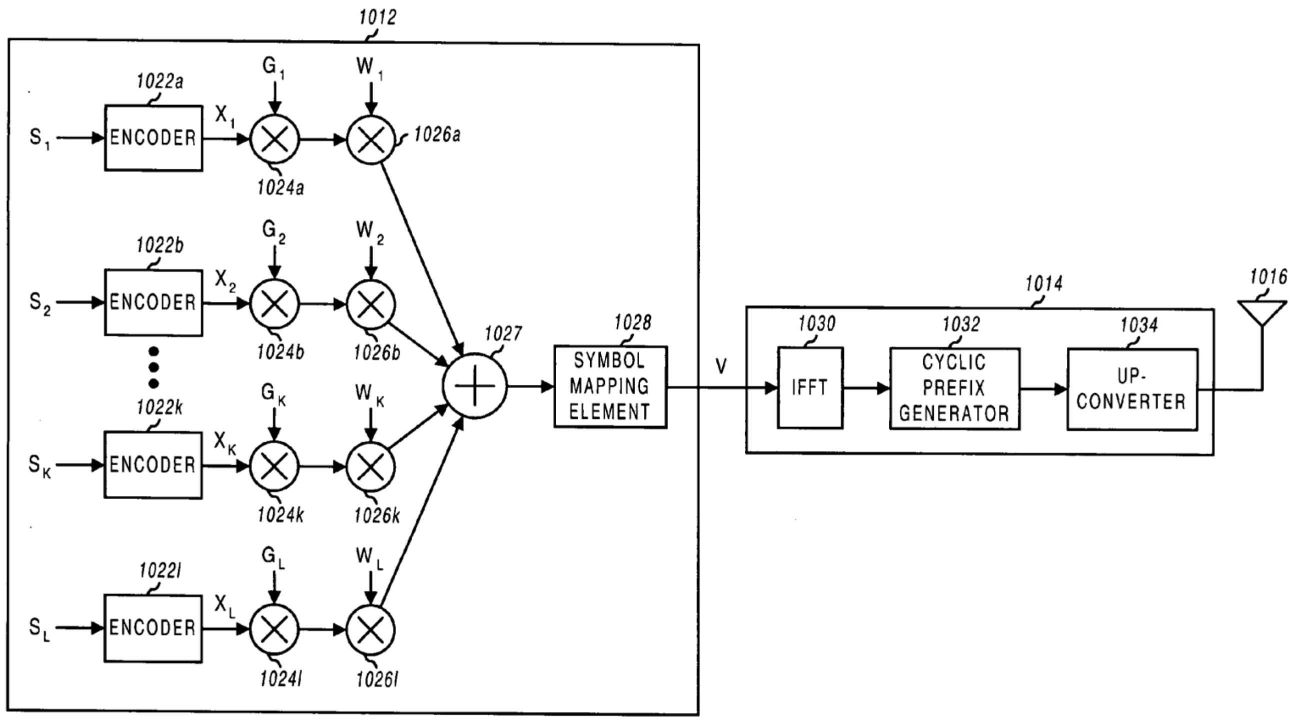
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 22 of the ’802 Patent	Prior Art Reference – Jalali
[22.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[22.2] wherein the second data corresponds to the first data and wherein the power amplifier outputs a third up-converted signal comprising the up-converted first analog	Jalali discloses “wherein the second data corresponds to the first data and wherein the power amplifier outputs a third up-converted signal comprising the up-converted first analog signal and the up-converted second analog signal.” See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream

Claim 22 of the ’802 Patent	Prior Art Reference – Jalali
signal and the up-converted second analog signal.	to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  **FIG. 2**

Claim 22 of the ’802 Patent	Prior Art Reference – Jalali
	See, e.g., Jalali at Figure 2.  FIG. 9 *See, e.g.*, Jalali at Figure 9.

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 22 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 22 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Ref erring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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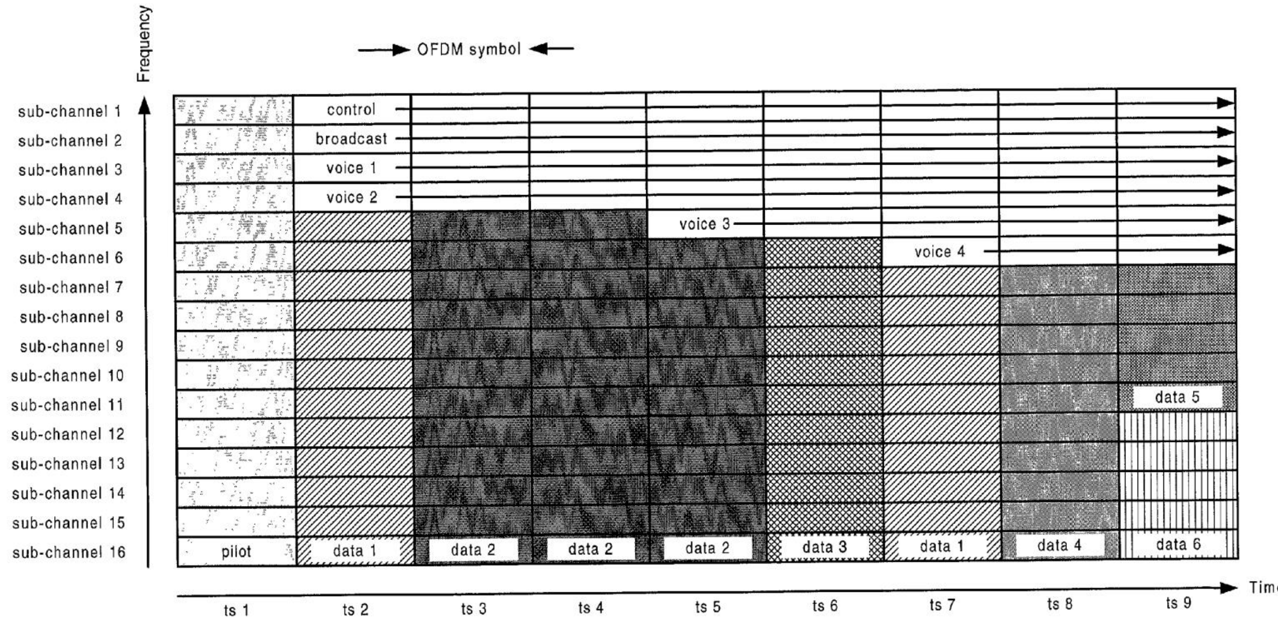
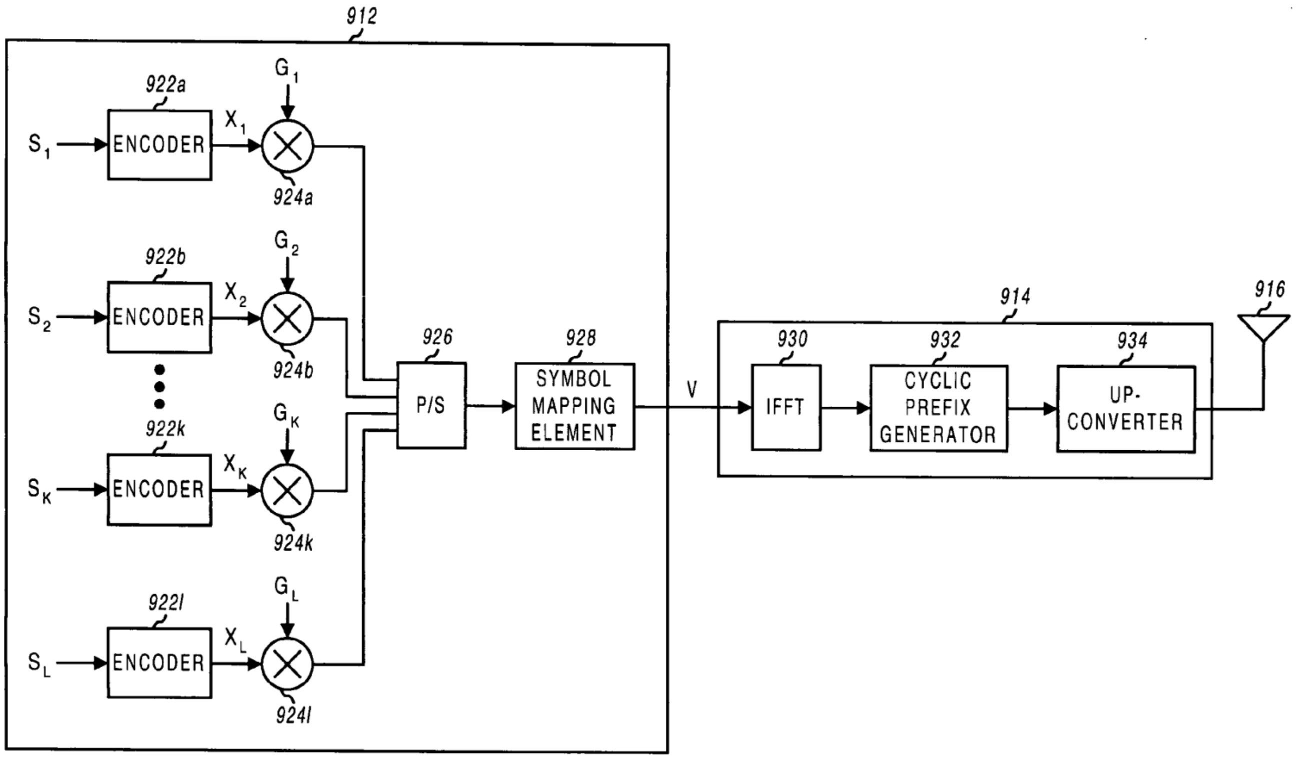
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

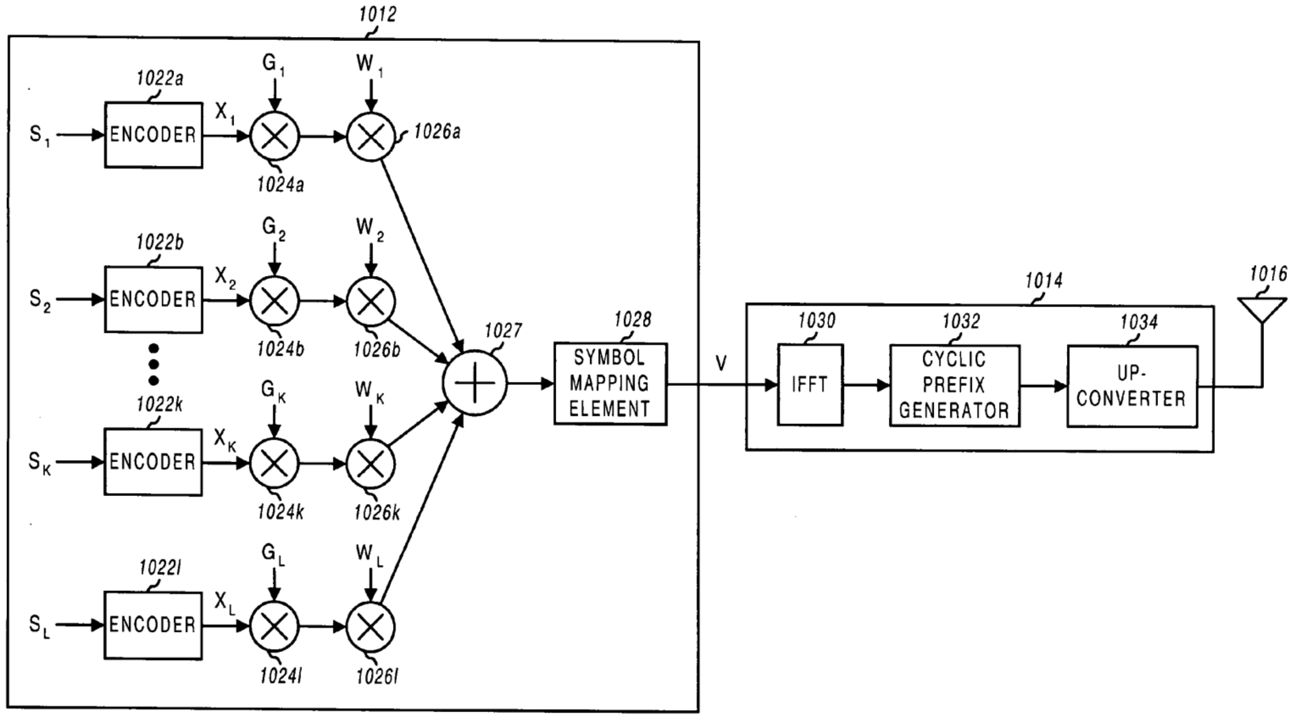
Claim 22 of the ’802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

Claim 23 of the ’802 Patent	Prior Art Reference – Jalali
[23.1] The communication system of claim 17	Jalali discloses all the elements of claim 17 for all the reasons provided above.
[23.2] wherein first and second data to be transmitted comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first up-converted frequency range	Jalali discloses “wherein first and second data to be transmitted comprise a plurality of OFDM symbols, wherein a first symbol is transmitted during a first time slot across the first up-converted frequency range and a second symbol is transmitted during the first time slot across the second up-converted frequency range, and wherein a third symbol is transmitted during a second time slot across the first up-converted frequency range and a fourth symbol is transmitted during the second time slot across a second up-converted frequency range.” See, e.g.:

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
and a second symbol is transmitted during the first time slot across the second up-converted frequency range, and wherein a third symbol is transmitted during a second time slot across the first up-converted frequency range and a fourth symbol is transmitted during the second time slot across a second up-converted frequency range.	Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	 *FIG. 2* *See*, *e.g.*, Jalali at Figure 2.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	 **FIG. 10** *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 23 of the ’802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

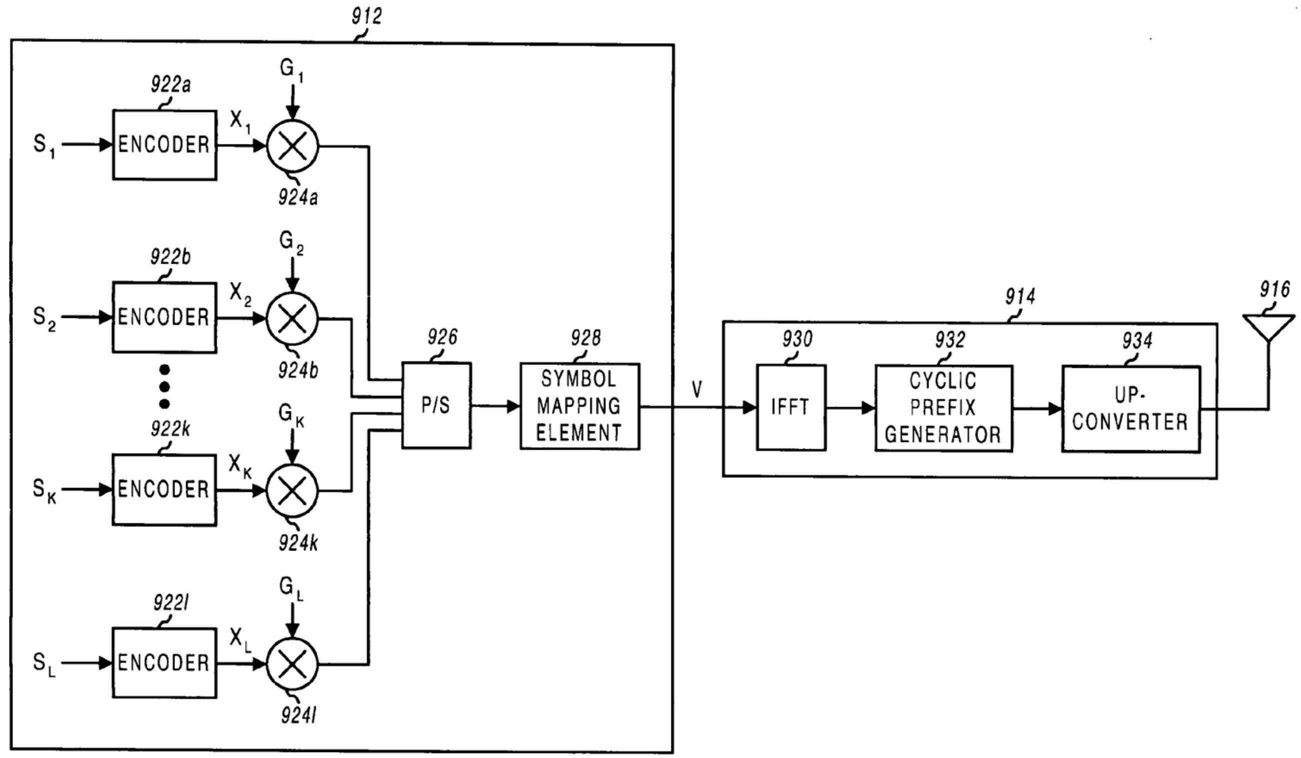
Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

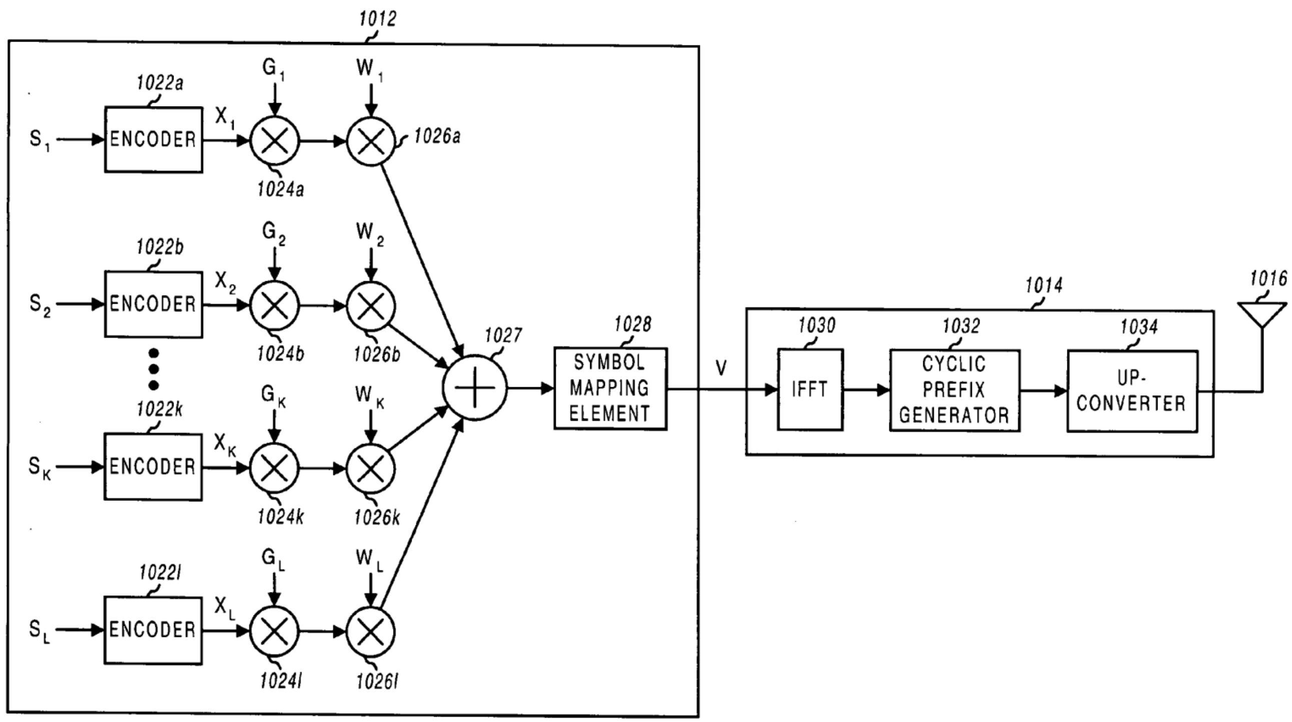
Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

Claim 23 of the '802 Patent	Prior Art Reference – Jalali
	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.

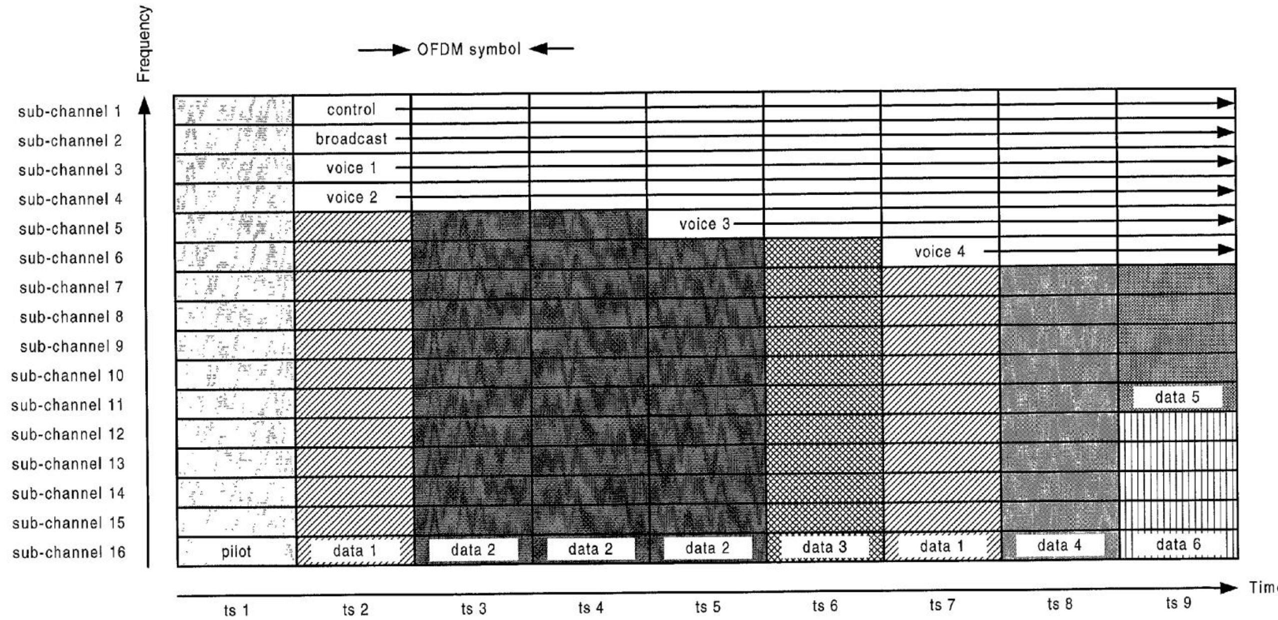
Claim 24 of the '802 Patent	Prior Art Reference – Jalali
[24.1] An electronic circuit comprising:	To the extent the preamble is limiting, Jalali discloses "An electronic circuit comprising." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol.

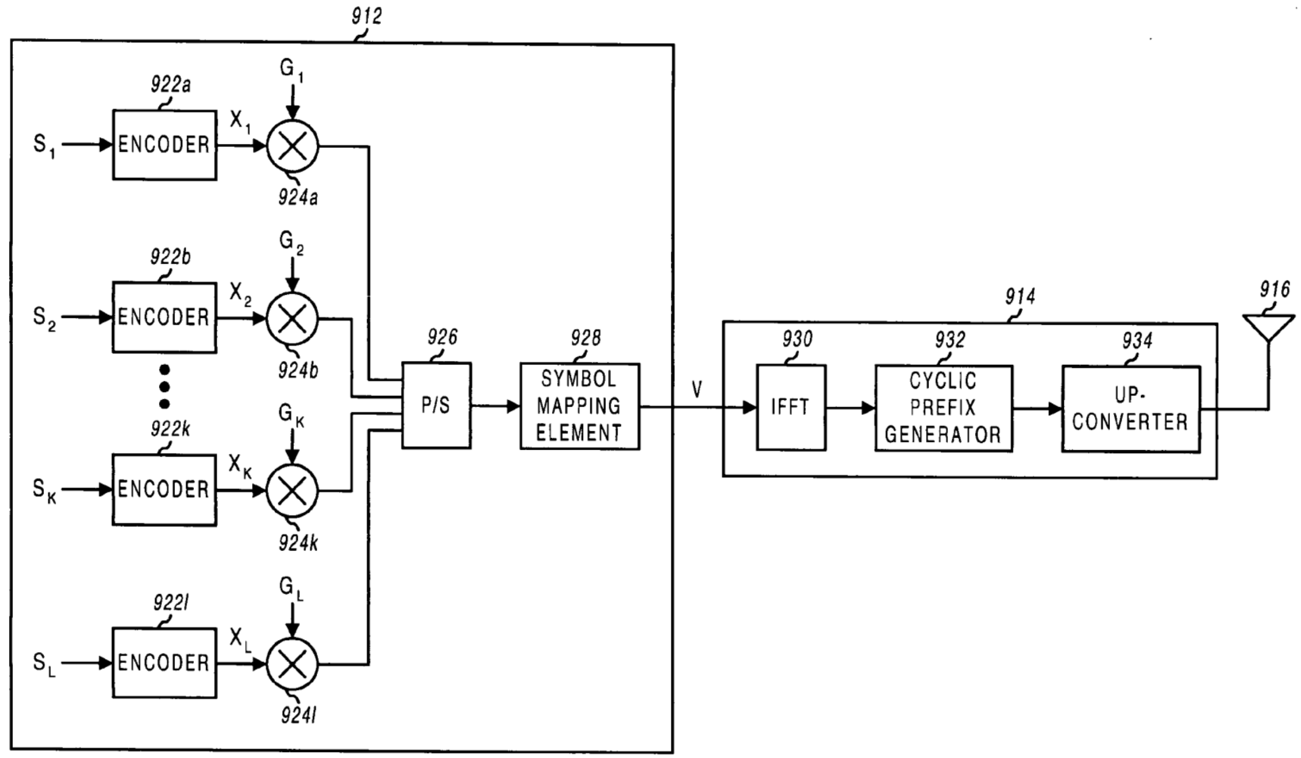
Claim 24 of the ’802 Patent	Prior Art Reference – Jalali
	The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more “circuits”. Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See*, *e.g.*, Jalali at Abstract.

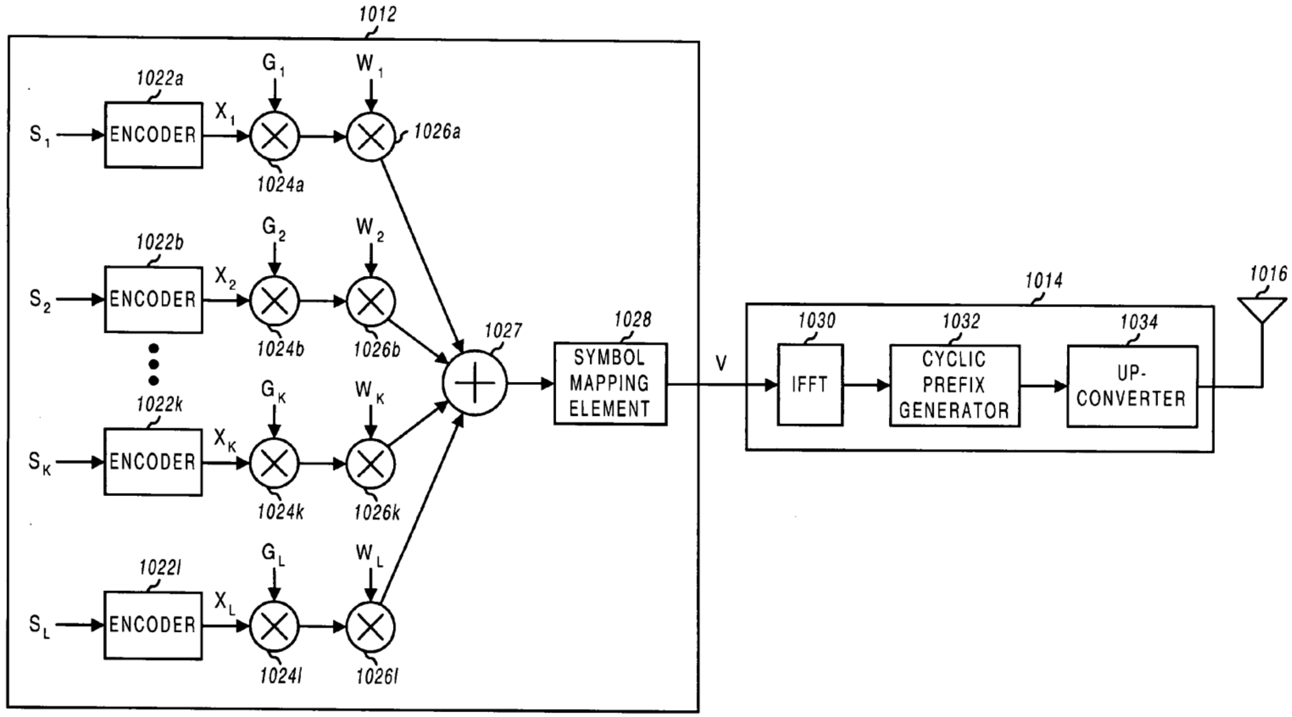
Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 9 *See*, *e.g.*, Jalali at Figure 9.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.2] a first down-converter circuit having a first input coupled to receive a first up-converted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted signal on the first down-converter output;	Jalali discloses "a first down-converter circuit having a first input coupled to receive a first up-converted signal, a second input coupled to receive a first demodulation signal having a first RF frequency, and an output, wherein the first down-converter circuit outputs a first down-converted signal on the first down-converter output." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	 *FIG. 2* *See*, *e.g.*, Jalali at Figure 2.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	 *FIG. 9* *See*, *e.g.*, Jalali at Figure 9.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

Claim 24 of the '802 Patent	Prior Art Reference – Jalali
	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

Claim 24 of the ’802 Patent	Prior Art Reference – Jalali
	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled “Turbo Code Interleaver Using Linear Congruential Sequences” and in a document entitled “The cdma2000 ITU-R RTT Candidate Submission,” hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.3] a second down-converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-	Jalali discloses "a second down-converter circuit having a first input coupled to receive the first up-converted signal, a second input coupled to receive a second demodulation signal having a second RF frequency different than the first RF frequency, and an output, wherein the second down-converter outputs a second down-converted signal on the second down-converter output, wherein the first up-converted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol

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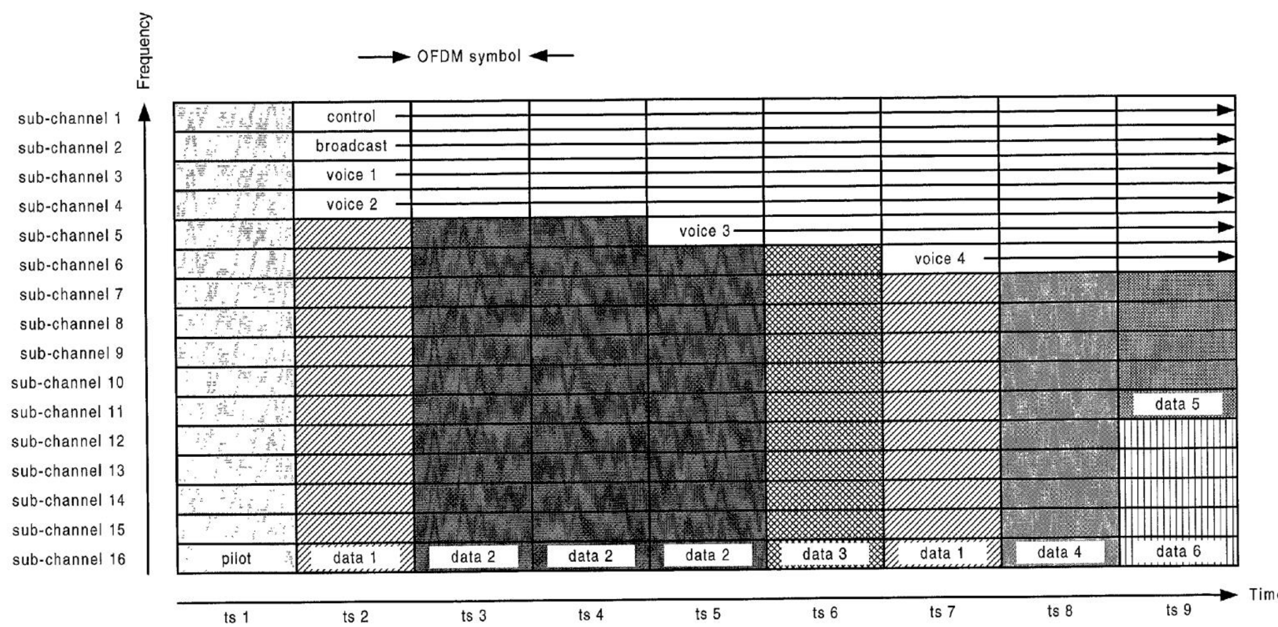
converted signal on the second down-converter output, wherein the first up-converted signal comprises a first signal modulated at the first RF frequency and a second signal modulated at the second RF frequency; and	vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more "circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  *FIG. 2* *See, e.g.*, Jalali at Figure 2.

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	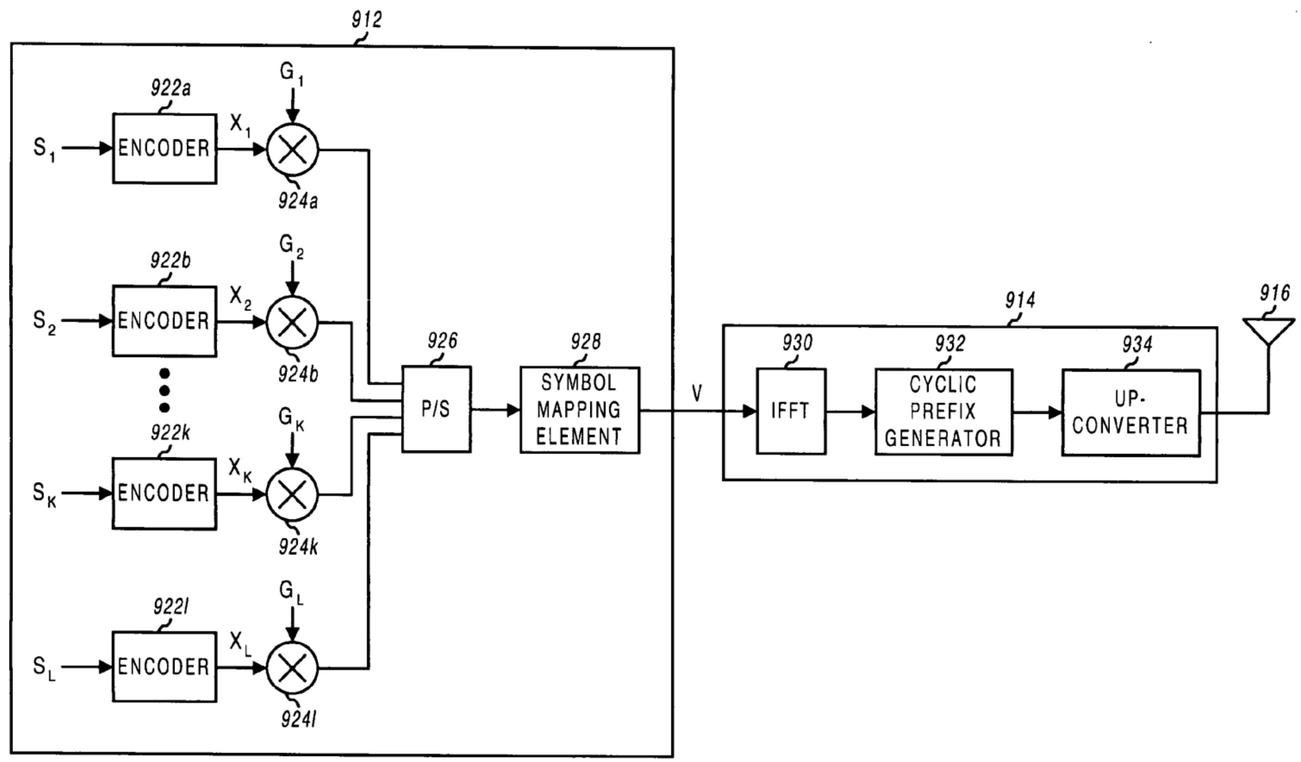 FIG. 9 *See, e.g.*, Jalali at Figure 9.

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	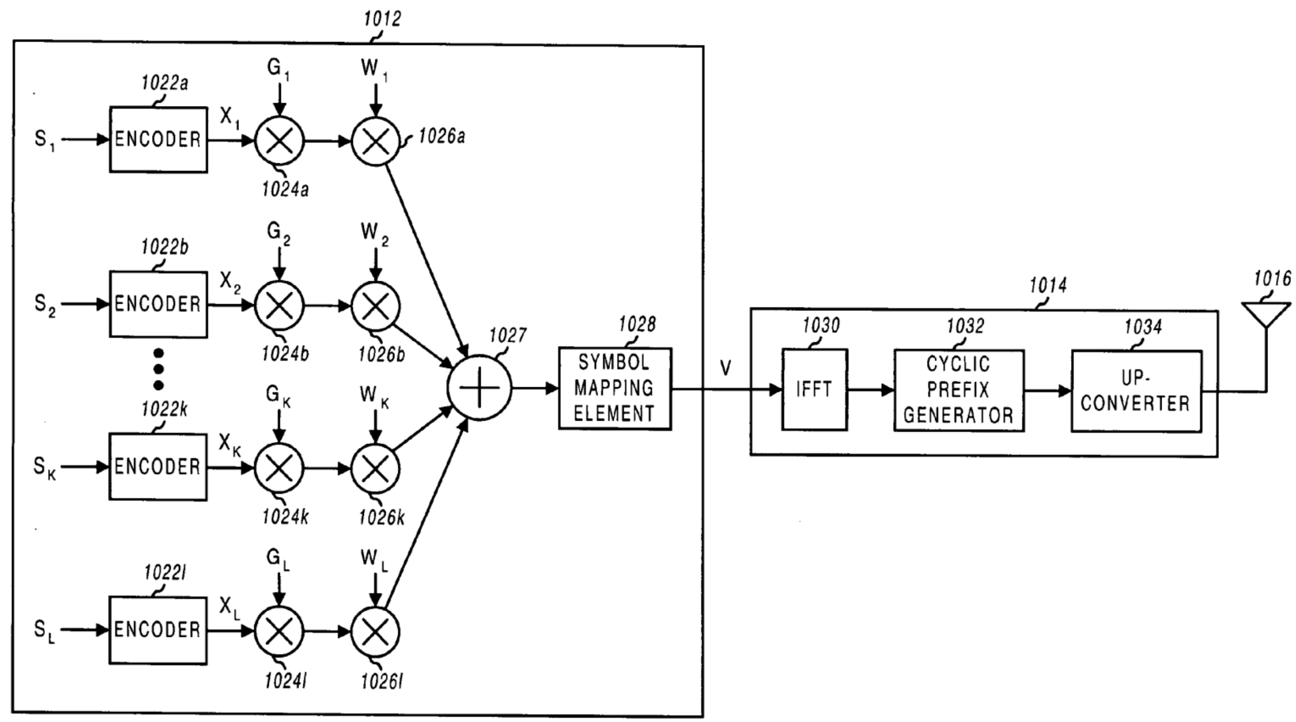 FIG. 10 *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.
[24.4] a filter having an input coupled to the output of the first down-converter and the output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals.	Jalali discloses "a filter having an input coupled to the output of the first down-converter and the output of the second down-converter, and in accordance therewith, the filter receives the first and second down-converted signals." See, e.g.: Transmitter and receiver units for use in an OFDM communications system and configurable to support multiple types of services. The transmitter unit includes one or more encoders, a symbol mapping element, and a modulator. Each encoder receives and codes a respective channel data stream to generate a corresponding coded data stream. The symbol mapping element receives and maps data from the coded data streams to generate modulation symbol vectors, with each modulation symbol vector including a set of data values used to modulate a set of tones to generate an OFDM symbol. The modulator modulates the modulation symbol vectors to provide a modulated signal suitable for transmission. The data from each coded data stream is mapped to a respective set of one or more

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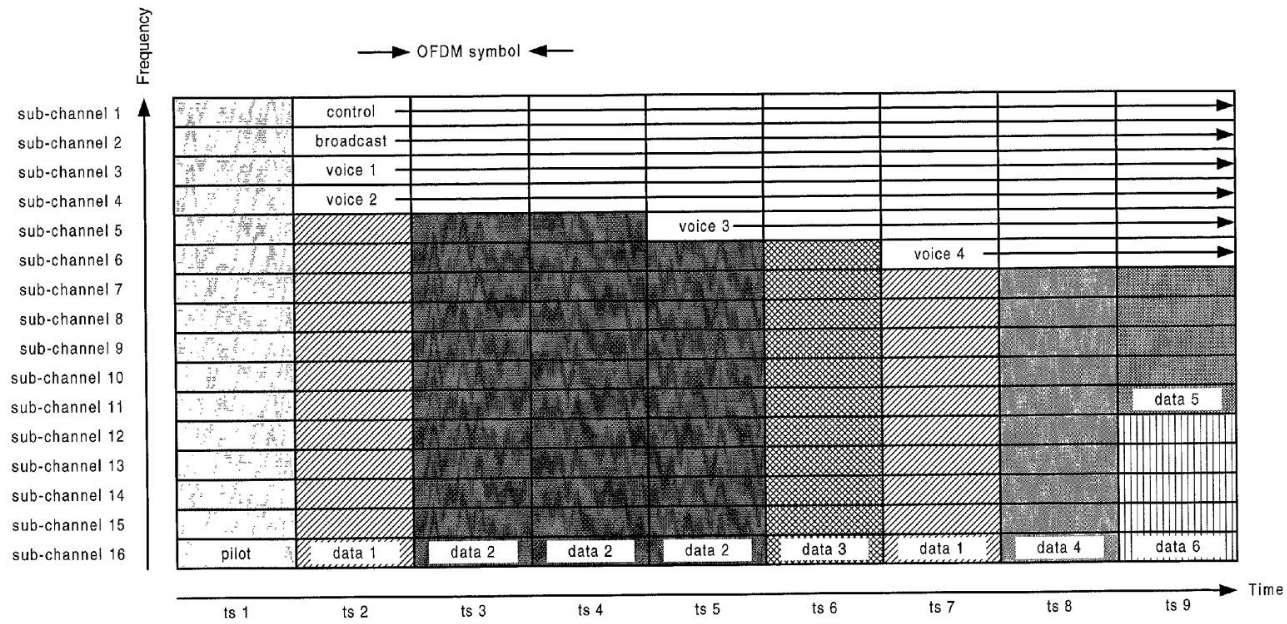
	"circuits". Each circuit can be defined to include a number of tones from a number of OFDM symbols, a number of tones from a single OFDM symbol, all tones from one or more OFDM symbols, or some other combination of tones. The circuits can have equal size or different sizes. Different circuits can be used for full rate data (e.g., active speech) and low rate data (e.g., silence periods). *See, e.g.*, Jalali at Abstract.  FIG. 2 *See, e.g.*, Jalali at Figure 2.

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	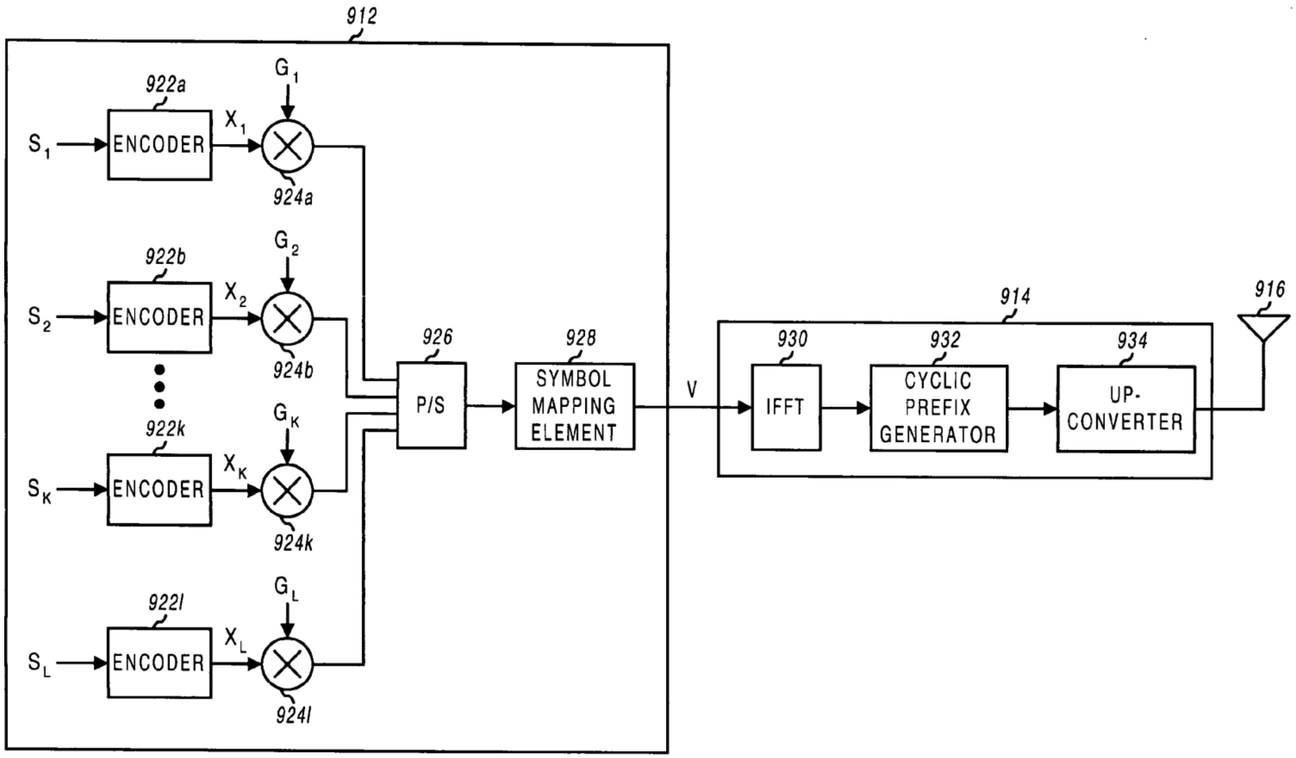 **FIG. 9** *See*, *e.g.*, Jalali at Figure 9.

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	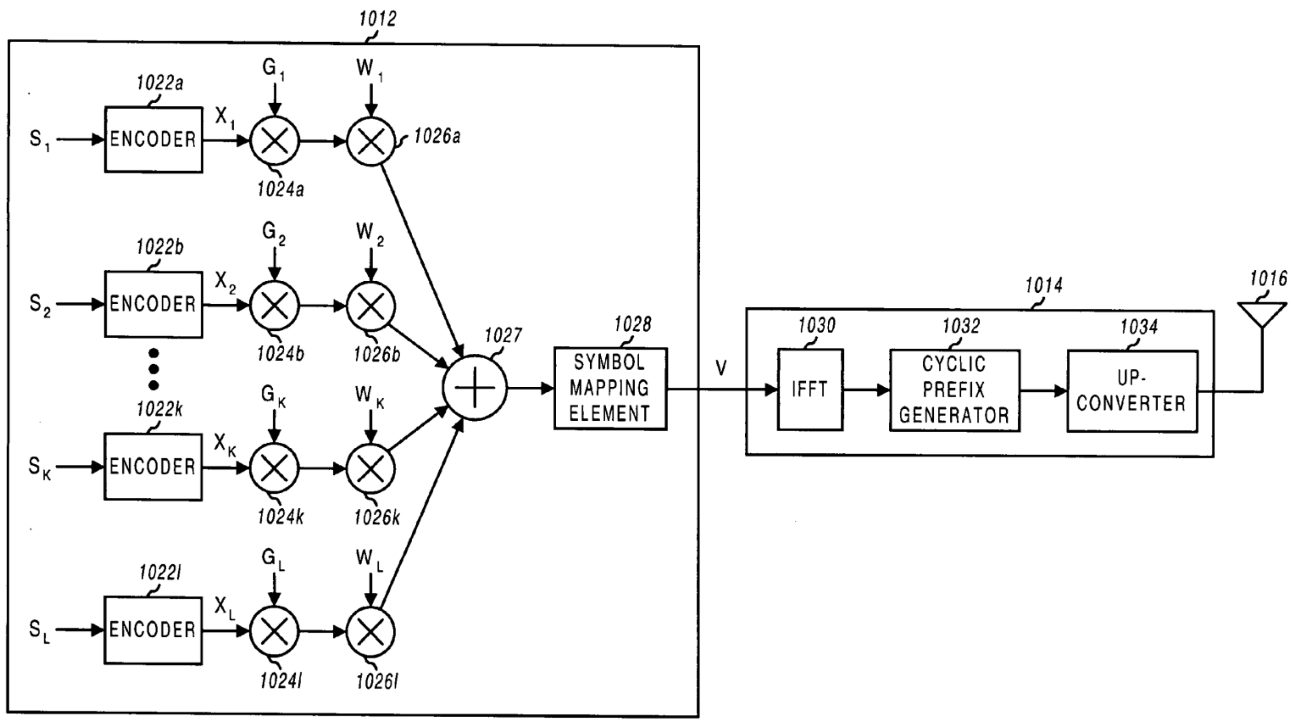 *FIG. 10* *See, e.g.*, Jalali at Figure 10. The present invention relates to data communication. More particularly, the present invention relates to a novel and improved communications system employing multi-carrier modulation and having high efficiency, improved performance, and enhanced flexibility. *See, e.g.*, Jalali at 1:24-28.

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	In accordance with another aspect of the invention, frequency diversity can be achieved by employing a multi-carrier modulation scheme. One such scheme that has numerous advantages is OFDM. With OFDM modulation, the overall transmission channel is essentially divided into a number of (L) parallel sub-channels that are used to transmit the same or different data. The overall transmission channel occupies the total operating bandwidth of W, and each of the sub-channels occupies a sub-band having a bandwidth of W/L and centered at a different center frequency. Each sub-channel has a bandwidth that is a portion of the total operating bandwidth. Each of the sub-channels may also be considered an independent data transmission channel that may be associated with a particular (and possibly unique) processing, coding, and modulation scheme, as described below. The data may be partitioned and transmitted over any defined set of two or more sub-bands to provide frequency diversity. For example, the transmission to a particular subscriber unit may occur over sub-channel 1 at time slot 1, sub-channel 5 at time slot 2, sub-channel 2 at time slot 3, and so on. As another example, data for a particular subscriber unit may be transmitted over sub-channels 1 and 2 at time slot 1 (e.g., with the same data being transmitted on both sub-channels), sub-channels 4 and 6 at time slot 2, only sub-channel 2 at time slot 3, and so on. Transmission of data over different sub-channels over time can improve the performance of a communications system experiencing frequency selective fading and channel distortion. Other benefits of OFDM modulation are described below. In accordance with yet another aspect of the invention, temporal diversity is achieved by transmitting data at different times, which can be more easily accomplished using time division multiplexing (TDM). For data services (and possibly for voice services), data transmission occurs over time slots that may be selected to provide immunity to time dependent degradation in the communications link. Temporal diversity may also be achieved through the use of interleaving. For example, the transmission to a particular subscriber unit may occur over time slots 1 through x, or on a subset of the possible time slots from 1 through x (e.g., time slots 1, 5, 8, and so on). The amount of data transmitted at each time slot may be variable or fixed. Transmission over multiple

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	time slots improves the likelihood of correct data reception due to, for example, impulse noise and interference. The combination of antenna, frequency, and temporal diversity allows the communications system of the invention to provide robust performance. Antenna, frequency, and/or temporal diversity improves the likelihood of correct reception of at least some of the transmitted data, which may then be used (e.g., through decoding) to correct for some errors that may have occurred in the other transmissions. The combination of antenna, frequency, and temporal diversity also allows the communications system to concurrently accommodate different types of services having disparate data rate, processing delay, and quality of service requirements. *See*, *e.g.*, Jalali at 8:47-9:38. FIG. 2 is a diagram that graphically illustrates at least some of the aspects of the communications system of the invention. FIG. 2 shows a specific example of a transmission from one of NT transmit antennas at a transmitter unit. In FIG. 2, the horizontal axis is time and the vertical axis is frequency. In this example, the transmission channel includes 16 sub-channels and is used to transmit a sequence of OFDM symbols, with each OFDM symbol covering all 16 sub-channels (one OFDM symbol is indicated at the top of FIG. 2 and includes all 16 sub-bands). A TDM structure is also illustrated in which the data transmission is partitioned into time slots, with each time slot having the duration of, for example, the length of one modulation symbol (i.e., each modulation symbol is used as the TDM interval). The available sub-channels can be used to transmit signaling, voice, traffic data, and others. In the example shown in FIG. 2, the modulation symbol at time slot 1 corresponds to pilot data, which is periodically transmitted to assist the receiver units synchronize and perform channel estimation. Other techniques for distributing pilot data over time and frequency can also be used and are within the scope of the present invention. In addition, it may be advantageous to utilize a particular modulation scheme during the pilot interval if all sub-channels are employed (e.g., a PN code with a chip duration of approximately 1/W). Transmission of the pilot modulation symbol typically occurs

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	at a particular frame rate, which is usually selected to be fast enough to permit accurate tracking of variations in the communications link. *See, e.g.*, Jalali at 13:49-14:11. In accordance with certain embodiments of the invention that provide the most flexibility and are capable of achieving high performance and efficiency, each sub-channel at each time slot for each transmit antenna may be viewed as an independent unit of transmission (i.e., a modulation symbol) that can be used to transmit any type of data such as pilot, signaling, broadcast, voice, traffic data, and others, or a combination thereof (e.g., multiplexed voice and traffic data). In such design, a voice call may be dynamically assigned different sub-channels over time. Flexibility, performance, and efficiency are further achieved by allowing for independence among the modulation symbols, as described below. For example, each modulation symbol may be generated from a modulation scheme (e.g., M-PSK, M-QAM, and others) that results in the best use of the resource at that particular time, frequency, and space. A number of constraints may be placed to simplify the design and implementation of the transmitter and receiver units. For example, a voice call may be assigned to a particular sub-channel for the duration of the call, or until such time as a sub-channel reassignment is performed. Also, signaling and/or broadcast data may be designated to some fixed sub-channels (e.g., sub-channel 1 for control data and sub-channel 2 for broadcast data, as shown FIG. 2) so that the receiver units know a priori which sub-channels to demodulate to receive the data. Also, each data transmission channel or sub-channel may be restricted to a particular modulation scheme (e.g., M-PSK, M-QAM) for the duration of the transmission or until such time as a new modulation scheme is assigned. For example, in FIG. 2, voice call 1 on sub-channel 3 may use QPSK, voice call 2 on sub-channel 4 may use 16-QAM, data 1 transmission at time slot 2 may use 8-PSK, data 2 transmission at time slots 3 through 5 may use 16-QAM, and so on.

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	The use of TDM allows for greater flexibility in the transmission of voice data and traffic data, and various assignments of resources can be contemplated. For example, a user can be assigned one sub-channel for each time slot or, equivalently, four sub-channels every fourth time slot, or some other allocations. TDM allows for data to be aggregated and transmitted at designated time slot(s) for improved efficiency. *See, e.g.*, Jalali at 15:26-16:3. The encoding may include error correction coding or error detection coding, or both, used to increase the reliability of the link. More specifically, such encoding may include, for example, interleaving, convolutional coding, Turbo coding, Trellis coding, block coding (e.g., Reed-Solomon coding), cyclic redundancy check (CRC) coding, and others. Turbo encoding is described in further detail in U.S. patent application Ser. No. 09/205,511, filed Dec. 4, 1998 entitled "Turbo Code Interleaver Using Linear Congruential Sequences" and in a document entitled "The cdma2000 ITU-R RTT Candidate Submission," hereinafter referred to as the IS-2000 standard, both of which are incorporated herein by reference. *See, e.g.*, Jalali at 16:35-47. FIG. 9 is a block diagram of an embodiment of a data processor 912 and a modulator 914 that can be used to multiplex multiple users on orthogonal OFDM tones. Channel data streams S1 through SK can be used to carry data for users 1 through K, respectively. Additional channel data streams (e.g., SL) can be used to carry data for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 922 that codes the received data with a particular coding scheme selected for that channel. For example, the coding scheme can include convolutional coding, Turbo coding, or no coding at all. The encoded data streams X1 through XL from encoders 922 a through 922 l are then provided to respective multipliers 924 a through 924 l, which also receive respective scaling factors G, through GL. Each multiplier 924 scales the received data stream with the received scaling factor to provide power adjustment for the data stream.

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	The scaled data streams from multipliers 924 a through 924 lare then provided to a parallel to serial converter (P/S) 926 that multiplexes the received data streams into a combined data stream. A symbol mapping element 928 then receives the combined data stream and interleaves (i.e., reorders) the data in the stream to provide temporal diversity. Symbol mapping element 928 further maps the data in each received data stream to the tones assigned to the data stream, as described below. The output from symbol mapping element 928 is a stream of modulation symbol vectors V, which is provided to modulator 914. Within modulator 914, an IFFT 930 receives and converts the modulation symbol vectors V into their time-domain representations called OFDM symbols. In an embodiment, for each modulation symbol vector converted to an OFDM symbol, cycle prefix generator 932 repeats a portion of the time-domain representation of the OFDM symbol to form a transmission symbol. The cyclic prefix ensures that the transmission symbol retains its orthogonal properties in the presence of multipath delay spread, thereby improving performance against deleterious path effects, as described above. The transmission symbols from cycle prefix generator 932 are then processed by upconverter 934, converted into an analog signal, modulated to a RF frequency, and conditioned (e.g., amplified and filtered) to generate an RF modulated signal that is then transmitted from an antenna 916. In an embodiment, symbol mapping element 928 maps the symbols for each channel data stream (e.g., each user) to a set of tones that are assigned to the channel. Referring back to FIG. 8A, each partition includes a number of OFDM symbols and, referring back to FIG. 1, each OFDM symbol includes a number of tones transmitted on a number of sub-channels. Thus, a number of tones in each partition are available for transmitting the channel data streams. *See, e.g.*, Jalali at 26:55-27:42. FIG. 10 is a block diagram of an embodiment of a data processor 1012 and a modulator 1014 that can be used to multiplex multiple users on the same OFDM tones using orthogonal (e.g., Walsh) codes. Similar to FIG. 9, channel data streams S1 through SL can be used to carry data for users and for control, signaling, broadcast, and other overhead channels. Each channel data stream is provided to a respective encoder 1022 that codes the received data with a particular coding scheme selected for that

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	channel. The encoded data streams X1 through XL from encoders 1022 a through 1022 l are then provided to respective multipliers 1024 a through 1024 l, which also receive respective scaling factors G1 through GL. Each multiplier 1024 scales the received data stream with the received scaling factor to provide power control for the data stream. The scaled data streams from multipliers 1024 a through 1024 l are then provided to respective multipliers 1026 a through 1026 l, which also receive respective Walsh sequences W1 through WL. Each multiplier 1026 covers the received data stream with the received Walsh sequence to provide a covered data stream. The covered data streams from multipliers 1026 a through 1026 l are provided to, and combined by a summer 1027 to generate a combined data stream. A symbol mapping element 1028 receives the combined data stream and interleaves the data in the stream to provide temporal diversity. The output from symbol mapping element 1028 is a stream of modulation symbol vectors V, which is then provided to modulator 1014. Modulator 1014 includes an IFFT 1030, a cyclic prefix generator 1032, and an upconverter 1034 that operate in similar manner as IFFT 930, cyclic prefix generator 932, and upconverter 934, respectively, in FIG. 9. Modulator 1014 generates an RF modulated signal that is transmitted from an antenna 1016. *See, e.g.*, Jalali at 31:48-32:14. For fixed application, a directional antenna can be used at the base station for forward link transmissions, and two receive antennas can be provided at the user terminal to achieve receive diversity. This configuration can provide a high carrier-to-interference ratio (C/I), which results in a large capacity (e.g., a hundred or more voice users may be serviced by 1.25 MHz on the forward link). For the Walsh cover multiplexing scheme, the channel estimates can be more accurate for fixed applications and where directional antennas are deployed. This allows for more accurate equalization of the transmission channel to maintain orthogonality of the Walsh covered data. *See, e.g.*, Jalali at 33:7-18.

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	As shown above, the transmitter unit and receiver unit are each implemented with various processing units that include various types of data processor, encoders, IFFTs, FFTs, demultiplexers, combiners, and so on. These processing units can be implemented in various manners such as an application specific integrated circuit (ASIC), a digital signal processor, a microcontroller, a microprocessor, or other electronic circuits designed to perform the functions described herein. Also, the processing units can be implemented with a general-purpose processor or a specially designed processor operated to execute instruction codes that achieve the functions described herein. Thus, the processing units described herein can be implemented using hardware, software, or a combination thereof. *See, e.g.*, Jalali at 33:41-54. Furthermore, this claim element is obvious in light of Jalali itself, when combined with any of the other references as charted for this claim element in Exs. A-1–A-31, First Supplemental Ex. A-Obviousness Chart, and/or when combined with the knowledge of one of ordinary skill in the art. Motivations to combine may come from the knowledge of the person of ordinary skill themselves, or from the known problems and predictable solutions as embodied in these references. Further motivations to combine references and additional details may be found in the Cover Pleading and First Supplemental Ex. A-Obviousness Chart.